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A REVIEW OF TEXTURES FOUND IN COMMERCIAL TITANIUM SHEET

ANTHONE ZARKADES and FRANK R. LARSON
DEVELOPMENT AND ENGINEERING LABORATORY

December 1971

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ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

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13. ABSTRACT

A compilation of data generated during studies concerning the development and characterization of titanium textures is presented. Results include pole figures, elastic and plastic properties in tension, and microstructures. Materials were examined in the as-received condition and in some cases after various heat treatments.

A wide range of textures were found for nine titanium alloys including commercially pure, Ti-6Al-4V, Ti-4Al-3Mo-1V, Ti-8Al-1Mo-1V, Ti-6Al-6V-2Sn, Ti-8Mn, Ti-4Al-4Mn, Ti-16V-2.5Al, and Ti-7Al-3Mo. The textures found indicate that the technological barrier for application of texture strengthening is due to the lack of established mill procedures for developing the desired texture and not that the specific preferred orientations are unattainable in titanium alloys. (Authors)

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Technical Report by

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ABSTRACT

A compilation of data generated during studies concerning the development and characterization of titanium textures is presented. Results include pole figures, elastic and plastic properties in tension, and microstructures. Materials were examined in the as-received condition and in some cases after various heat treatments.

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CONTENTS

INTRODUCTION

As a result of early interest in the anisotropic properties of titanium sheet,[1] a continuing study of the preferred crystallographic texture found in commercial titanium alloy sheets has been carried out over the last several years. This study has resulted in the accumulation of a large number of actual pole figures along with the mechanical properties of these sheets. As time passed, various programs were carried out in order to ascertain how certain types of textures were developed, and a greater understanding is now available by which the known textures can be classified. Since the interest in textures is increasing, particularly from a research and development standpoint, it seems important to record the results of these findings. Another important factor is that it is becoming more and more apparent that texture is a basic parameter necessary to understand and control such properties as Young's modulus, yield strength, tensile strength, Poisson's ratio, and toughness.

The awareness of the commercial importance of texture has, for the most part, been confined to magnetic sheet materials; however, the utilization of texture for the improvement of other properties will undoubtedly follow. How soon effective commercial usage can come about depends upon how readily the textures can be controlled and also how much specific gain may be obtained. In other words, it becomes a matter of difficulties versus advantages. In order to speed the day when textures can be commercially employed, a large effort toward developing a greater understanding of the fundamentals will be necessary.

The first step in texture control originates with the various processing stages at the mill. In most cases, ingot texture is of little significance since the large shape change resulting from processing is usually sufficient to eliminate ingot texture; thus, the last stages of deformation and heating produce most of the changes in the texture. Therefore, effective texture control can be obtained via precision heating and deformation schedules.

In the case of titanium, which exhibits a high degree of preferred orientation, very little information has been published regarding texturing; therefore, the process control of textures is not very well understood. One of the first steps in developing understanding of textures in commerical titanium alloys would be to determine textures in different sheets within the alloys of interest. This therefore constituted the main part of this program. Another phase of this study was to report the effects of heat treatment and alloying on the texture and mechanical properties.

TEXTURES IN TITANIUM

The purpose of this section is to review the textures found in titanium sheets, so that those listed in the Appendixes can be classified according to type or past processing history (much in the manner of the characterization of microstructure). The excellent review of textures in wrought and annealed

metals by Dillamore and Roberts[2] is a good starting point. A more detailed discussion of the actual mechanics of texture formation is available in previous reports.[3-10] The most prominent of several basic types of titanium sheet textures found is the cold-rolled sheet.[11] A similar type is also found if the sheet is warm rolled between room temperature and about 1400F. This texture is characterized by having a basal (0002) pole intensity on the sheet normal (SN) transverse direction (TD), and a great circle at about 27 to 30 degrees from the SN. This texture is further defined by stating that the (10$\bar{1}$0) poles lie near, or in, the rolling direction (RD). This is shown in Figure 1 and is called an alpha deformation texture.

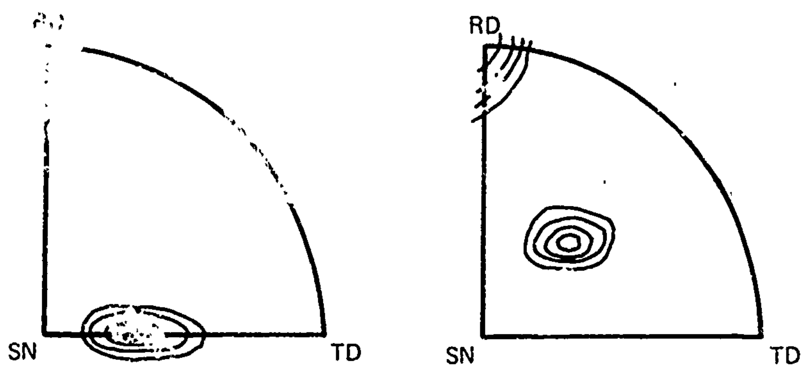


Figure 1. Alpha Deformation Texture

Annealing of cold- or warm-rolled sheets has only a slight sharpening effect upon the (0002) poles. However, the (10$\bar{1}$0) poles rotate through an arbitrary angle of approximately 30 degrees about the C axis, resulting in the texture shown in Figure 2. This is called an annealed alpha deformation texture.

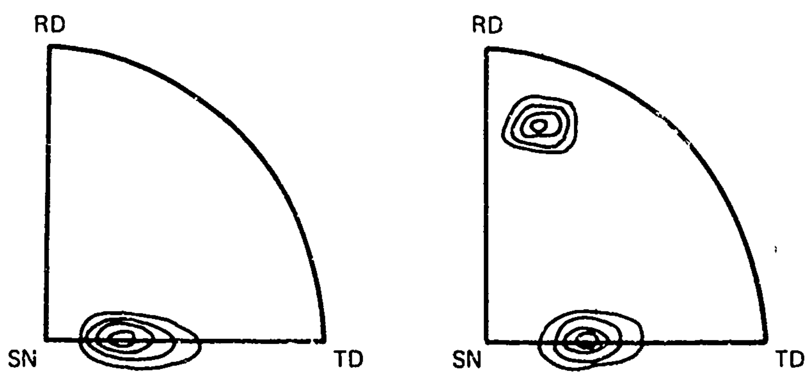
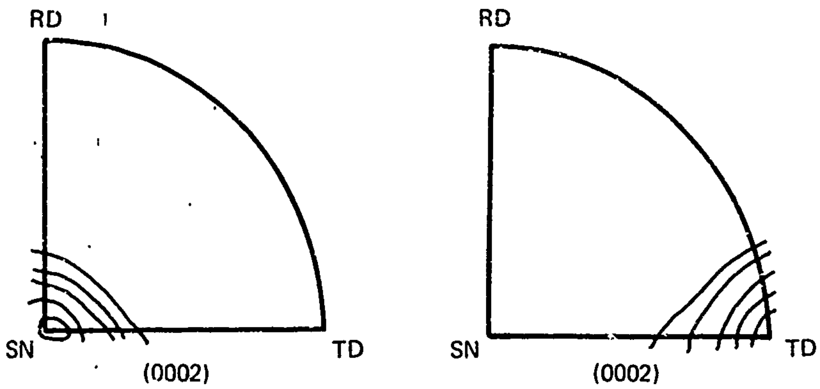


Figure 2. Annealed Alpha Deformation Texture

In most cases, it is not necessary to distinguish between an annealed and a cold-worked texture since many properties are symmetrical about the C axis. Thus, a basal pole figure is sufficient to define the crystallographic influence, and the above texture can be modified by either hot rolling[12] (above 1400F but not above beta transus) and/or alloying. Important observations in relation to texture hardening were the early discovery that additions of aluminum (approximately 4 percent) and the most recent disclosure that copper (approximately 0.5 percent) produce the "ideal" texture.[4] It has also been established that the ideal texture can be produced by round rolling.[5] In fact, it seems possible to change the angle at which the basal pole lies from the sheet normal by combinations of alloying and hot rolling.[4] Figure 3 illustrates this for two cases.



"IDEAL" TEXTURE
COLD ROLLED Ti-4Al, Ti-0.55Cu
ROUND ROLLED Ti-6Al-4V

HOT ROLLING TEXTURE
Ti-6Al-4V (1700F) COLD
ROLLED Ti-8Mn

Figure 3. Extremes of Basal Pole Rotation

Sufficient amount of beta stabilizers (more than 15 percent volume retained beta at room temperature) or hot rolling in the alpha-beta field will cause a texture transition, and the new texture will have a basal pole figure which looks like the magnesium or zinc type as shown in Figure 4.

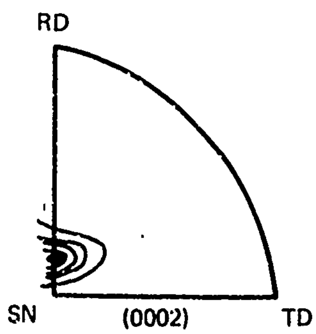


Figure 4. Magnesium or Zinc Texture Formed When Alpha-Beta Alloy (Greater Than 15 Volume Percent Beta) Is Worked

The final important texture found in titanium is that which develops from a beta-worked material and is a result of the Burgers transformation relationship $\{0001\}_\alpha \parallel \{110\}_\beta$, $<11\bar{2}0>_\alpha \parallel <111>_\beta$.[15] It can be seen that since the basal plane in the alpha is parallel to the (110) plane in the beta, a determination of the (110) pole figure will give the basal pole figure after transformation. As in most bcc metals, hot or warm sheet rolling produces a texture which has a strong (100) [011] texture component.[16]

Other minor orientation peak components are not usually found in titanium. If the composition has sufficient alloying to retain the beta at room temperature, the texture in Figure 5 will usually be found. On the other hand, if the beta deformation texture is developed by hot working in the beta field and transformation occurs on cooling or on aging as part of the heat treatment, the alpha basal pole figure will bear a simple relationship to the beta texture, as shown in Figure 6. However, there are some other textures that can be formed, but, these are of less commerical importance because they are infrequent and are a result of special processing or heat treatments. For example, a cube or (100) [011] texture can be formed by heating very high in the beta field, but this rarely happens in production because of the excessively large grain growth. For the most part, the textures found in commercial sheet and shown in the appendixes are either single type, as described above, or a simple combination of two basic types.

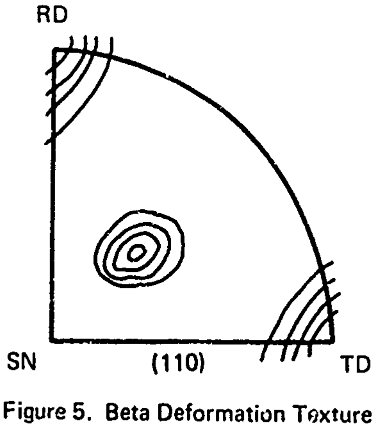


Figure 5. Beta Deformation Texture

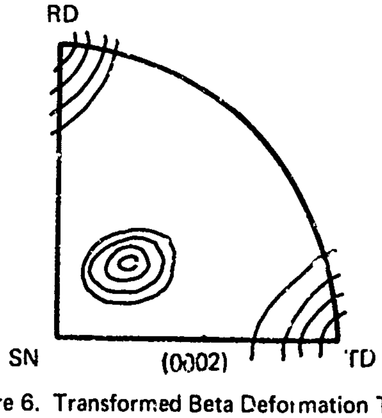


Figure 6. Transformed Beta Deformation Texture

TEXTURE DETERMINATION

One quadrant pole figure was determined utilizing a unique reflection technique described by Lopata and Kula.[17] Specimen preparation for this method conists of cutting strips from the rolled sheet 45 degrees to the rolling direction, bonding them together, and grinding a surface which will have its normal equidistant from the rolling direction, transverse direction, and rolling plane normal. The whole thickness of the material is used, and the resultant pole figures are an average of the interior and surface textures. The position of the plane and the pole of this surface in a single quadrant are shown in Figure 7. The specimen after polishing is set in the goniometer with the proper 2θ Bragg angle and is rotated through an azimuth and declination angle. X-ray intensities are recorded with corresponding angular alpha and beta positions and are then plotted to construct iso-intensity contour lines. The pole figures obtained in this manner have iso-intensities labeled 10, 20, 30 etc. and were determined by Strathmore Research Corporation.* Other textures illustrated in this report have the contour lines identified as 1, 2, 3....8. These pole figures were obtained on an automatic plotted pole figure which was developed at AMMRC.[18] This setup concurrently plots intensity versus azimuthal and declination angle, thereby automatically producing a texture diagram. This has eliminated the tedious and time consuming hand plotting of data previously required. Depending on dominating phase, alpha or beta, the basal plane (0002) or (110) pole figure was determined.

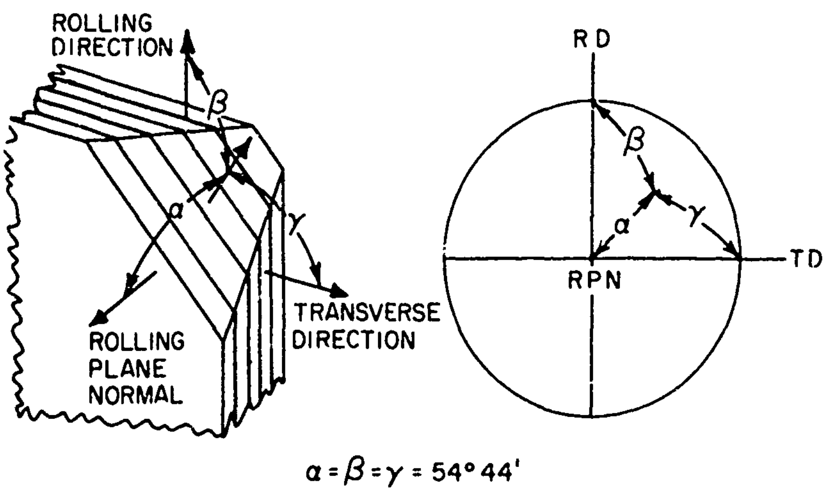


Figure 7. Position of Oblique Plane for Determining One Quadrant of Pole Figure by Reflection[17]

*Strathmore Research Corporation, Contract DAAG-46-67-0-0019, Cambridge, Massachusetts.

MECHANICAL PROPERTIES

Sheet tension specimens were machined at various angles to the rolling direction. In some instances, data are shown for specimens from 0 to 180 degrees. The transverse specimen would coincide with 90 degrees and longitudinal tests would be marked as 0 or 180 degrees. The test setup and testing procedure are identical to those published in prior reports.[19,20] A schematic of test setup and specimen orientation is shown in Figures 8 and 9. Some materials were subjected to various heat treatments, and these are indicated in the Appendices along with photomicrographs.

RESULTS AND DISCUSSION

For the most part commercially pure sheets show classical alpha deformation textures. However, there were two notable exceptions, RC-55-53230-2 and Ti-75A-M290, each of which has remnants of a transformed beta deformation texture. In an RC-55 heated between 1400 and 1700F, there is no change of the alpha deformation texture with increasing temperature (see Table Ia).

Table Ia. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR COMMERCIALLY PURE TITANIUM

(SEE APPENDIX I)

Alloy	Heat No.	Thickness, in.	Condition*	Texture Type†
RC55	5-5032BM2	0.125	A.R.	α Deformation
RC55	53230-2	0.050	A.R.	Dual α deformation (ideal and TD Orientations)
RC55	53284-BM4	0.130	A.R.	α deformation
RC55	NHN	0.140	ST 1400F 1 hr	α deformation
RC55	NHN	0.140	ST 1500F 1 hr	α deformation
RC55	NHN	0.140	ST 1600F 1 hr	α deformation
RC55	NHN	0.140	ST 1700F 1 hr	α deformation
Ti100A	L730	0.065	A.R.	Dual α deformation
Ti100A	L657	0.030	A.R.	α deformation
Ti100A	L658	0.030	A.R.	α deformation
Ti75A	L550	0.060	A.R.	α deformation
Ti75A	M290	0.100	A.R.	Dual α deformation and transformed β deformation

*A.R. — As received. ST — Solution treated followed by air cooling.
†(0002) Pole figure, except where noted.

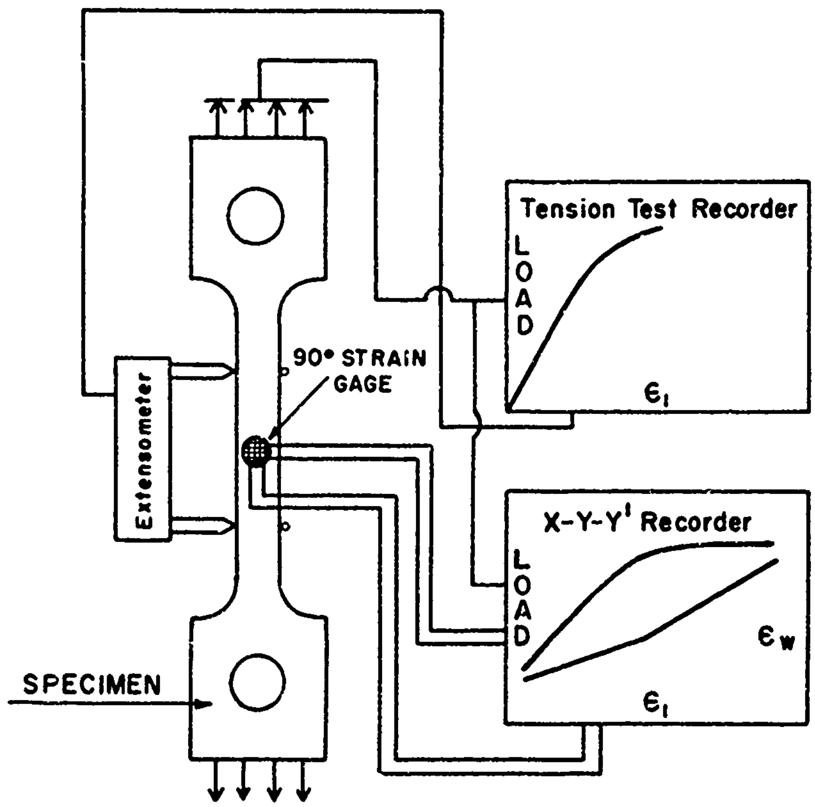


Figure 8. Schematic of Testing Apparatus

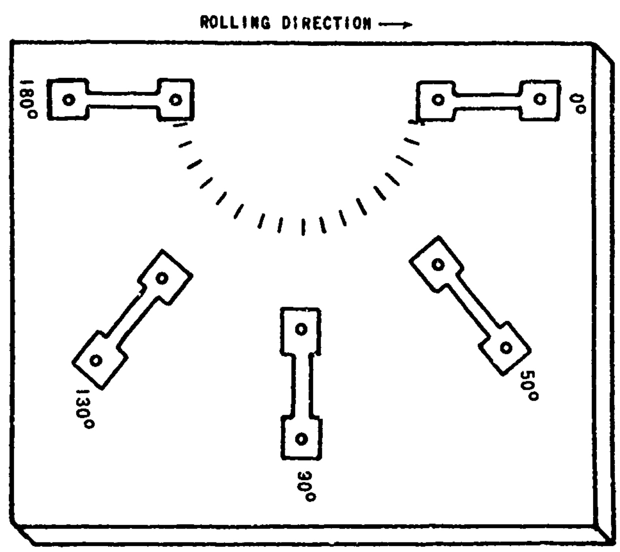


Figure 9. Tension Specimen Orientation

The Ti-6Al-4V alloy sheets (Table Ib) had several different texture types. One common texture observed for this alloy was a dual- or two-component texture where one component was in the TD and the other was near the SN (Heat M7199). In some cases, the peak near the SN was very low and that near the TD very intense, Heat M2803 (0.070 in). However, there was a unique case where the texture was nearly random, Heat M27003. Heats M2803 (0.030 in) and B22075 had a transformed beta deformation texture. The effect of heat treatment (Heat M2803, 0.070 in) is also shown with the material undergoing a texture change from an alpha deformation to a transformed beta deformation type as it was heated higher and higher through the alpha plus beta field into the beta field.

Table Ib. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-6Al-4V

(SEE APPENDIX II)

Heat No.	Thickness, in	Condition*	Texture Type†
M7199	0.060	A.R.	Dual (T.D. α -deformation and Mg type)
B22075	0.130	A.R.	Transformed β deformation
M2803	0.070	A.R.	Dual (T.D. α -deformation and weak Mg type)
M2803	0.030	A.R.	Dual (strong T.D. α -deformation and remnants of β deformation)
M2803	0.060	STA-1450F 1/4 hr 1000F 4 hr	α Deformation (TD peak)
M2803	0.060	STA-1550F 1/4 hr 1000F 4 hr	α Deformation (TD peak)
M2803	0.060	STA-1650F 1/4 hr 1000F 4 hr	α Deformation (TD peak)
M2803	0.060	STA-1750F 1/4 hr 1000F 4 hr	Transformed β deformation
M27003	0.040	A.R.	Random
M27037	0.040	A.R.	Dual (α deformation and TD poles)

*A.R. — As received. STA — Solution treated, water quenched and aged.
†(0002) Pole figure, except where noted.

The alloy Ti-4Al-3Mo-IV (Table Ic) showed several cases of transformed beta deformation textures (Heats M8018, M8577, and M8173) heat treated. A dual-texture type similar to that found in Ti-6Al-4V was found in the case of Heat M8018 and, with increasing temperature, it went to a beta transformation type texture. Heat X70006 displayed a nearly ideal texture and the associated R values were very high, as would be expected.

Table Ic. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-4Al-3Mo-1V

(SEE APPENDIX III)

Heat No.	Thickness, in	Condition*	Texture Type†
M8018	0.060	STA-1400F 1/4 hr 1000F 4 hr	Dual α deformation and Mg type
M8018	0.060	STA-1500F 1/4 hr 1000F 4 hr	Dual α deformation and Mg type - slight peak
M8018	0.060	STA-1600F 1/4 hr 1000F 4 hr	Complex α deformation and Mg type-stronger peak in RD
M8018	0.060	STA-1700F 1/4 hr	Transformed β deformation type
M8577	0.065	A.R.	Transformed β deformation type
X70006	0.060	A.R.	Very near ideal
M8173	0.020	A.R.	Alpha phase transformed - β deformation - Beta Phase

*A.R. — As received. STA — Solution treated, water quenched and aged.
†(0002) Pole figure, except where noted

The Ti-8Al-1Mo-1V alloy single sheet examined had a transformed beta deformation texture. (See Table Id.)

Table Id. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-8Al-1Mo-1V

(SEE APPENDIX IV)

Heat No.	Thickness, in	Condition*	Texture Type†
V1848	0.130	A.R.	Transformed β deformation

*A.R. — As received.
†(0002) Pole figure.

The sheets of Ti-6Al-6V-2SN (Table Ie) also have textures which appeared to be one of the transformed beta deformation type.

Table Ie. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-6Al-6V-2Sn

(SEE APPENDIX V)

Heat No.	Thickness, in	Condition*	Texture Type†
S	0.115	A.R.	Transformed β deformation
H	0.115	A.R.	Transformed β deformation

*A.R. — As received.
†(0002) Pole figure.

Ti-8Mn (RC-130A) (Table If), except for one sheet which was nearly random, had textures of the dual alpha deformation type with the TD pole being of high intensity.

Table If. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-8Mn

(SEE APPENDIX VI)

Heat No.	Thickness, in	Condition*	Texture Type†
3442		A.R.	Near ideal
A3613	0.065	A.R.	α deformation - TD Peak
A5227-7	0.030	A.R.	α deformation - very strong TD peak
A5221-16	0.120	A.R.	Dual (α deformation - strong TD peak + Mg peak)

*A.R.— As received.
†(0002) pole figure.

Ti-4Al-4Mn (RC 130B) (Table Ig). Heats B3263-B1 and B3319-2 both showed a deformation type texture with a single peak near or at the TD. Upon heating, Heat B3263-B1 developed a secondary peak near the SN; then, at 1700 F, a transformed beta deformation texture resulted.

Table Ig. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-4Al-4Mn

(SEE APPENDIX VII)

Heat No.	Thickness, in	Condition*	Texture Type†
B3319-2	0.065	A.R.	α deformation - strong TD peak
B3263-B1	0.055	A.R.	α deformation - strong TD peak
B3263-B1	0.055	STA-1300F 3/4 hr 1000F 8 hr	Dual (α deformation - TD peak + weak Mg peak)
B3263-B1	0.055	STA-1400F 3/4 hr 1000F 8 hr	Dual (α deformation - TD peak + weak Mg peak)
B3263-B1	0.055	STA-1500F 3/4 hr 1000F 8 hr	Dual (α deformation - TD peak + weak Mg peak)
B3263-B1	0.055	STA-1600F 3/4 hr 1000F 8 hr	Dual (α deformation - TD peak + weak Mg peak) slight RD peak
B3263-B1	0.055	STA-1700F 3/4 hr 1000F 8 hr	Beginning of β deformation type

*A.R.— As received. STA - solution treated, water quenched and aged.
†(0002) Pole figure except where noted.

Ti-16V-2.5Al metastable beta alloy (Table Ih) developed textures characteristic of the (100)[011] beta deformation in either the beta structure component or in an alpha transformation counterpart.

Table Ih. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-16V-2.5Al

(SEE APPENDIX VIII)

Heat No.	Thickness, in	Condition*	Texture Type†
B24814	0.030	STA-1200F 1/2 hr 975F 4 hr	β deformation
B24814	0.030	STA-1300F 1/2 hr 975F 4 hr	β deformation
B24814	0.030	STA-1400F 1/2 hr 975F 4 hr	Complex
B24814	0.030	STA-1450F 1/2 hr 975F 4 hr	Complex
B24814	0.030	A.R. + Aged 975F 4 hr	β deformation
B24814	0.030	ST + WQ 1450F 1/2 hr	Complex (coarse grain)
M22093	0.025	A.R.	β deformation
B22117	0.045	A.R.	β deformation
B22117	0.045	A.R. + 975F 4 hr.	Transformed β deformation
M24990	0.025	A.R.	Transformed β deformation
B24990	0.040	A.R.	β deformation
M23346	0.070	A.R.	Near transformed β deformation
T22154	0.065	A.R.	Dual α deformation
T24762	0.130	A.R.	Dual α deformation

*A.R. — As received. ST — Solution treated followed by air cooling. STA — Solution treated, water quenched and aged.
†(0002) Pole figure, except where noted.

The single sheet of alloy Ti-7Al-3Mo (Table Ii) had a dual texture of the alpha deformation type with a high intensity near the SN, probably similar to that observed in the Ti-4Al binary alloys.

Table Ii. - CHARACTERIZATION OF SHEET MATERIALS AND TEXTURES FOR Ti-7Al-3Mo

(SEE APPENDIX IX)

Heat No.	Thickness, in	Condition*	Texture Type†
1295	0.060	A.R.	Dual (strong Mg peak +weak TD Peak)

*A.R. — As received.
†(0002) Pole figure.

CONCLUSIONS

It can be seen from examination of the appendixes that a wide range of textures are formed in the titanium alloy sheet. This wide range of textures is of commercial significance from two major points. First, from the standpoint of anisotropy of properties, it appears that a beta deformation or a transformed beta deformation texture will give the least anisotropy because it is orthotropic. The second main point is that an alpha deformation texture composed of basal poles in the transverse direction gives rise to highest degree of planar anisotropy. The technological barrier for the application of texture hardening or use of texture for dramatic improvements in many properties is not that the desired textures have not been found, since they do develop, but that the desired mill technique and procedures have not been determined and employed. It appears from textures found that virtually any described texture can be achieved and that the most sought-after texture of the "ideal" type can be achieved in several alloys.

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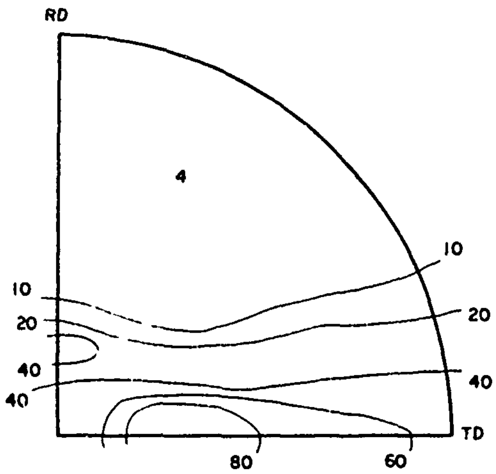
APPENDIX I
COMMERCIALLY PURE (UNALLOYED)

RC-55-5-5032BM2



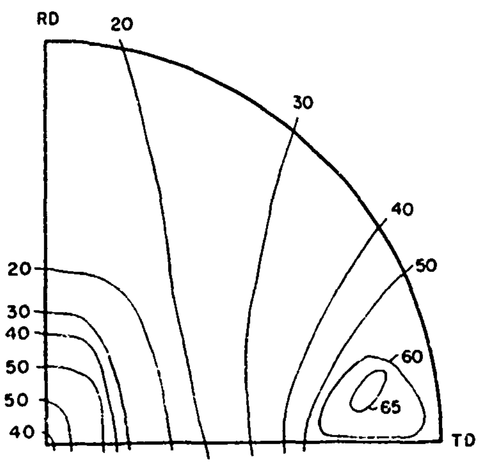
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)
10	0.125	0.314	0.473	14.0	54.0	56.0	72.2
20	0.125	0.353	0.626	15.6	52.7	55.4	70.8
30	0.125	0.375	0.696	15.5	57.1	59.0	69.6
40	0.125	0.383	0.734	14.8	57.7	59.4	68.5
50	0.125	0.375	0.777	16.0	57.5	59.1	67.5
60	0.125	0.364	0.784	16.4	60.9	62.5	69.9
70	0.125	0.370	0.764	17.1	61.4	62.8	69.6
80	0.125	0.387	0.830	16.9	63.5	64.9	72.0
90	0.125	0.386	0.804	16.8	62.8	64.9	72.8
100	0.125	0.379	0.855	16.8	62.0	63.5	71.4
110	0.125	0.373	0.822	16.2	62.3	63.7	70.5
120	0.125	0.364	0.801	15.9	60.7	62.0	68.8
130	0.125	0.377	0.785	15.9	59.4	60.9	68.6
140	0.125	0.357	0.641	16.2	58.2	59.8	68.8
150	0.125	0.367	0.696	14.9	57.4	59.2	70.0
160	0.125	0.366	0.658	15.5	55.7	57.9	71.0
170	0.125	0.364	0.596	15.2	54.4	57.4	73.1

RC-55-53230-2

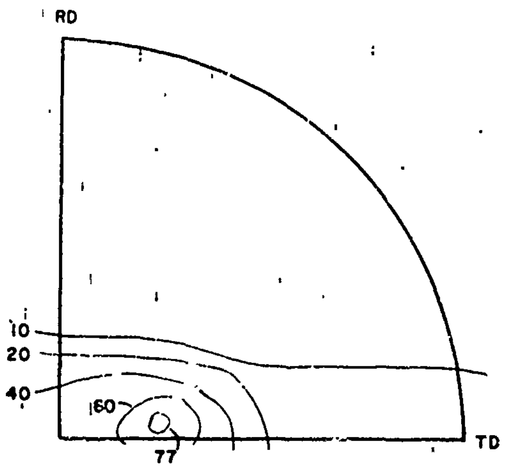


(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
0	0.050	0.333	0.483	16.1	59.3	61.2	82.4	31.0
10	0.051	0.343	0.510	16.3	61.0	62.7	83.3	28.0
20	0.052	0.389	0.698	16.0	68.7	70.8	85.6	30.0
40	0.053	0.378	0.815	15.8	74.2	75.8	83.7	29.5
45	0.052	0.387	0.750	16.1	73.4	74.3	81.5	25.0
50	0.052	0.390	0.773	16.4	76.3	77.0	83.4	28.0
70	0.052	0.400	0.765	16.9	78.0	79.5	85.7	26.0
80	0.052	0.387	0.757	16.6	76.8	79.0	85.9	28.0
90	0.051	0.385	0.719	16.9	75.7	76.9	83.7	23.0



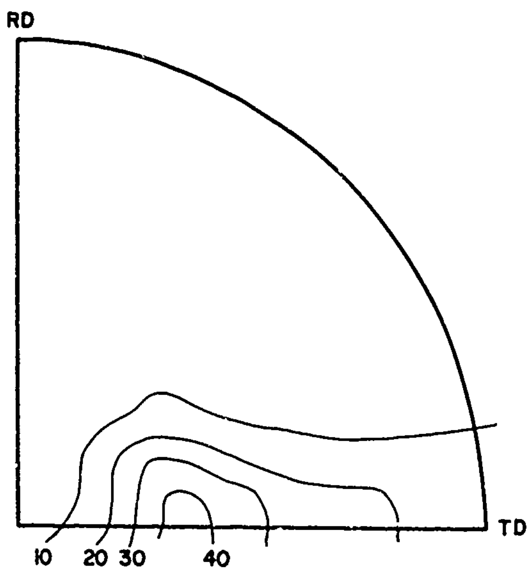
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

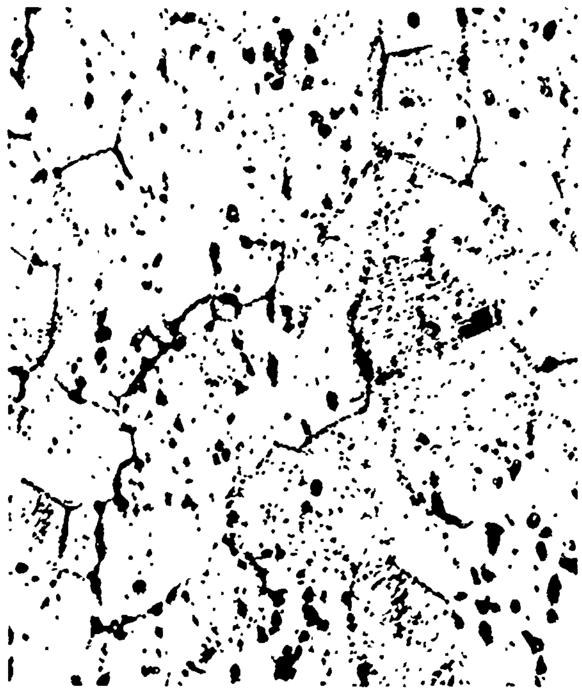
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
0	0.127	0.400	0.764	15.0	62.9	64.7	80.6	31.0
10	0.128	0.394	0.723	15.4	61.9	63.8	78.9	30.5
20	0.127	0.377	0.723	15.5	63.2	63.2	80.9	30.0
30	0.129	0.379	0.751	15.4	62.0	63.7	77.0	31.0
40	0.128	0.388	0.793	15.5	63.2	64.8	74.3	37.0
50	0.129	0.382	0.811	15.6	63.7	65.2	73.9	31.5
60	0.129	0.400	0.839	15.6	65.9	67.3	76.5	31.0
70	0.129	0.393	0.838	15.8	65.8	67.5	75.4	32.0
80	0.131	0.387	0.821	16.0	67.5	69.4	77.1	32.5
90	0.129	0.398	0.824	16.1	67.0	68.9	80.4	27.0

RC-55-1400F



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

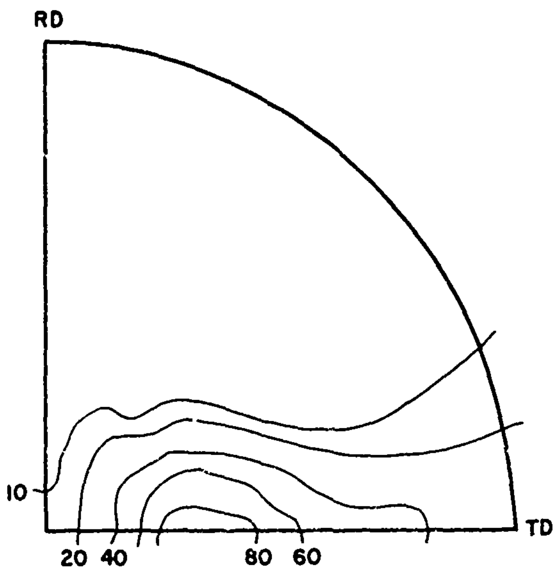
HEAT TREATMENT

Solution treated at 1400F, 2 hr w...

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
L	0.137	0.337	0.466	15.8	71.6		88.7	35.0

RC-55-1500F



(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

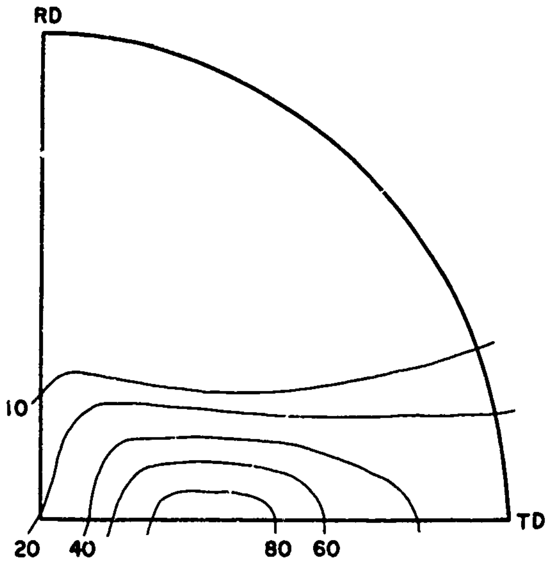
HEAT TREATMENT

Solution treated at 1500F, 2 hr w.q.

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
L	0.137	0.325	0.500	15.8	71.1	73.6	89.7	33.0

RC-55-1600F



(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

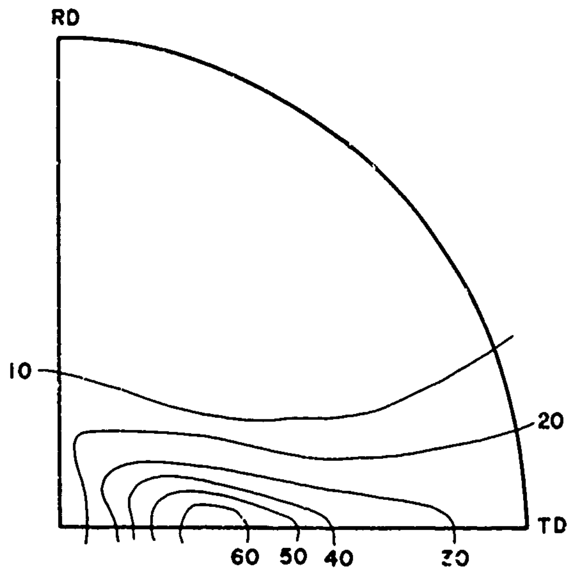
HEAT TREATMENT

Solution treated at 1600F, 2 hr w.q.

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
L	0.137	0.337	0.529	16.3	72.3	74.9	92.7	31.0

RC-55-1700F



(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

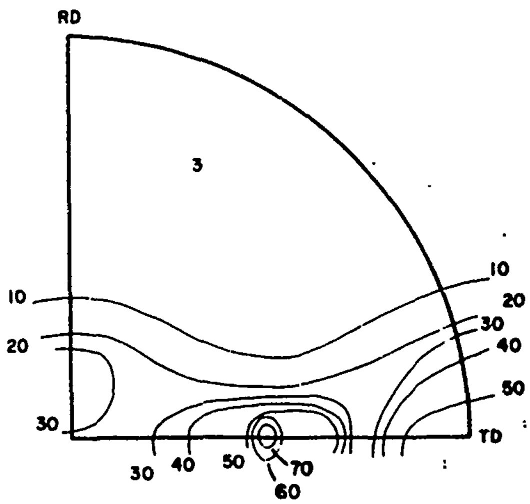
HEAT TREATMENT

Solution treated at 1700F, 2 hr w.q.

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
L	0.137	0.309	0.378	15.5	62.5	68.0	93.0	19.0

Ti-100A-L730



(0002) POLE FIGURE

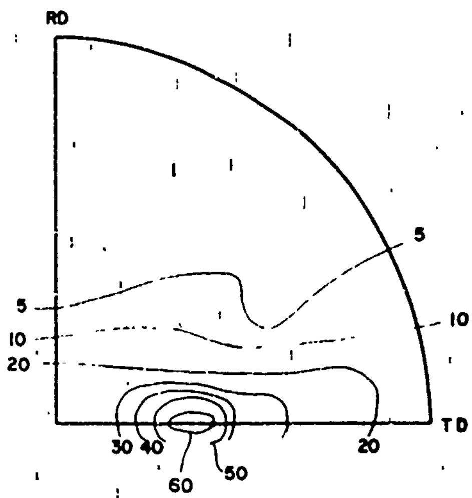
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
0	0.065	0.330	0.451	14.5	71.0	74.1	94.4	23.0
10	0.065	0.332	0.481	14.7	75.0	77.2	97.8	21.0
20	0.065	0.349	0.545	15.0	76.9	80.2	99.4	24.5
30	0.065	0.340	0.545	15.3	72.1	75.2	94.5	25.0
40	0.065	0.360	*	15.7	78.2	81.3	95.1	26.5
50	0.065	0.351	0.663	16.5	76.7	80.4	95.1	31.0
60	0.065	0.370	0.700	16.5	76.5	79.6	94.3	28.0
70	0.065	0.374	0.703	17.3	84.6	87.4	100.0	28.0
80	0.065	0.374	*	17.6	83.3	86.1	140.0	28.0
90	0.065	0.365	0.625	17.7	84.6	87.4	105.6	25.0

*Premature gage failure

Ti-100A-L657



(0002) POLE FIGURE

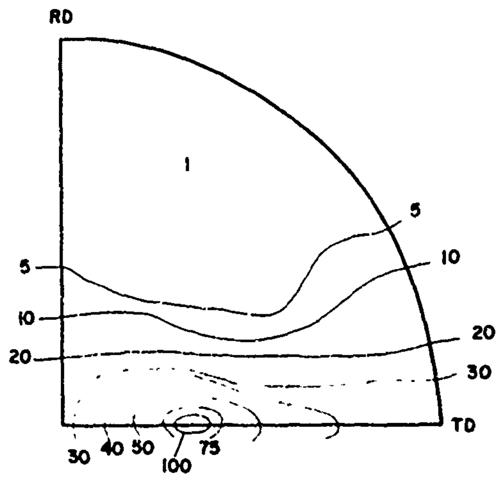
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thickness (inch)	μ_E	μ_p	Ex10[6] Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
0	0.029	0.352	0.552	15.4	72.8	76.6	96.6	22.0
10	0.030	0.356	0.552	15.7	70.0	74.0	94.3	28.0
20	0.030	0.364	0.587	15.2	70.3	74.3	93.3	27.5
30	0.030	0.400	0.666	15.4	68.9	71.7	88.0	29.5
40	0.030	0.391	0.725	15.2	68.3	73.0	88.7	28.5
50	0.030	0.393	*	15.2	68.7	73.3	89.0	27.5
60	0.030	0.393	0.622	15.5	72.0	76.7	90.0	28.0
80	0.030	0.400	0.713	16.0	74.0	78.0	92.0	27.0
90	0.029	0.358	0.631	15.7	73.8	77.6	93.1	23.0

*Premature gage failure

Ti-100A-L658



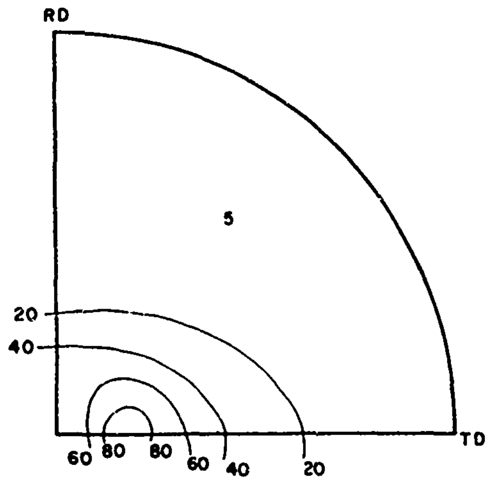
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)	Elon. (%)
0	0.030	0.349	0.547	15.5	69.7	74.0	96.0	20.5
10	0.030	0.357	0.523	15.7	73.3	76.7	96.7	23.0
20	0.029	0.353	0.516	15.7	75.9	79.7	97.9	22.0
30	0.030	0.362	0.614	15.9	75.7	79.3	95.3	31.0
40	0.030	0.381	0.683	15.9	78.7	81.3	94.7	26.5
50	0.030	0.375	0.677	17.2	78.1	81.5	94.7	28.0
60	0.030	0.386	0.719	17.2	82.8	86.4	98.7	28.5
70	0.030	0.381	0.714	17.5	77.7	81.7	95.3	25.5
80	0.031	0.411	0.692	17.0	79.0	82.6	95.8	26.5
90	0.031	0.390	0.692	16.5	79.6	84.2	100.7	23.0

Ti-75A-L550



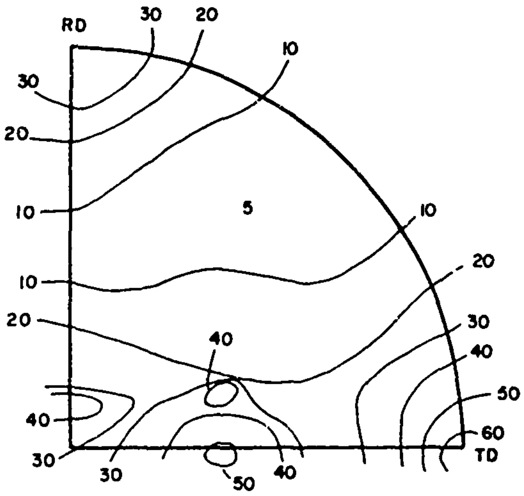
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)
10	0.063	0.377	0.686	16.1	69.4	72.6	89.4
20	0.063	0.386	0.707	15.5	69.5	73.0	87.6
30	0.063	0.382	0.744	15.4	71.1	74.0	87.9
40	0.063	0.396	0.794	15.6	68.4	70.9	82.8
50	0.063	0.404	0.831	16.3	70.5	73.3	84.1
60	0.063	0.392	0.838	16.4	71.1	72.5	84.4
70	0.063	0.407	0.859	16.5	70.8	73.0	83.8
80	0.063	0.414	0.873	17.2	71.1	73.2	85.1
90	0.063	0.404	0.855	17.0	71.4	73.3	84.4
100	0.063	0.407	0.857	16.7	70.1	72.3	82.9
110	0.063	0.404	0.859	16.4	71.8	73.7	83.9
120	0.063	0.404	0.848	16.4	70.4	72.5	82.3
130	0.063	0.393	0.812	16.0	68.5	70.4	81.9
140	0.063	0.396	0.787	15.4	68.8	71.0	83.0
150	0.063	0.386	0.759	16.1	69.5	71.7	84.7
160	0.063	0.386	0.706	15.4	69.6	72.0	87.3
170	0.063	0.386	0.683	15.5	68.0	70.9	88.3

Ti-75A-M290



(0002) POLE FIGURE

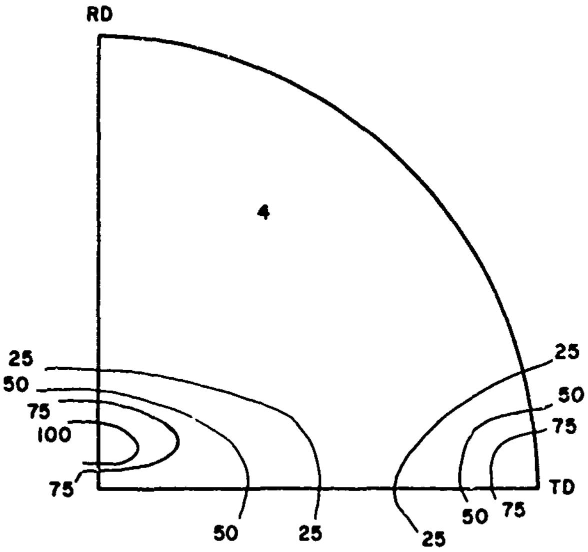
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick- ness (inch)	μ_E	μ_P	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (ksi)	Y.S. at 0.2% (ksi)	Tensile Strength (ksi)
0	0.107	0.322	0.438	15.8	65.2	67.8	87.2
10	0.107	0.331	0.466	14.4	66.2	69.3	87.6
20	0.107	0.333	0.488	15.8	66.6	69.3	87.3
30	0.107	0.345	0.551	15.4	68.0	70.7	86.1
40	0.107	0.357	0.600	14.9	68.0	71.6	84.8
50	0.107	0.364	0.652	16.5	67.6	70.7	84.0
60	0.107	0.346	0.673	15.8	71.1	13.8	85.9
70	0.107	0.380	0.720	17.0	74.1	76.7	88.8
80	0.107	0.369	0.697	17.4	73.4	76.5	90.2
100	0.107	0.365	0.696	17.3	77.5	80.0	91.4
110	0.107	0.359	0.712	16.2	73.1	76.4	88.2
120	0.107	0.358	0.699	17.1	72.7	75.6	87.0
130	0.107	0.351	0.671	15.2	71.0	73.6	86.0
140	0.107	0.350	0.620	15.4	69.8	72.2	85.7
150	0.107	0.350	0.554	14.4	67.8	70.8	86.1
160	0.107	0.333	0.462	14.5	67.8	70.2	87.0
170	0.107	0.339	0.479	15.3	66.2	68.9	87.8

APPENDIX II

Ti-6Al-4V-M7199



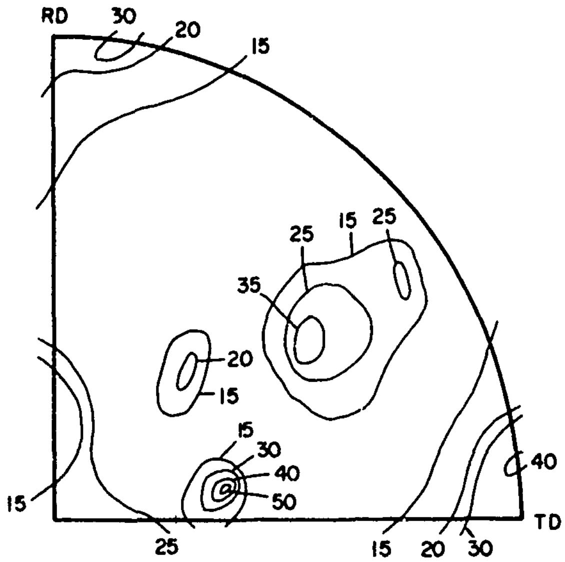
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
0	0.056	0.408	0.797	15.3	133,600	133,600	151,400
10	0.058	0.388	0.689	14.6	121,700	122,100	131,000
20	0.060	0.387	0.694	14.8	121,000	121,000	128,300
30	0.057	0.390	0.723	15.0	123,200	122,500	126,300
40	0.058	0.403	0.773	15.1	121,700	120,700	124,500
60	0.056	0.412	0.797	15.6	122,400	121,700	123,100
80	0.058	0.417	0.792	15.6	125,100	124,700	126,100
90	0.058	0.425	0.766	15.6	124,100	122,900	126,100
0	0.058	0.41	0.72	15.3	125,500	125,900	134,500
10	0.060	0.40	0.70	15.4	126,700	126,300	133,300
20	0.060	0.42	0.77	15.8	128,300	128,300	132,700
30	0.060	0.42	0.80	15.2	124,300	124,200	125,300
40	0.062	0.43	0.92	15.3	122,900	122,900	122,900
50	0.062	0.43	0.88	15.6	123,500	123,400	123,900
60	0.062	0.47	0.84	15.8	127,400	127,100	127,400
70	0.062	0.44	0.86	16.3	129,000	128,400	129,000
80	0.060	0.45	0.83	16.4	131,000	130,700	131,000
90	0.058	0.56	1.06	16.4	134,000	134,000	134,000

Ti-6Al-4V-B22075



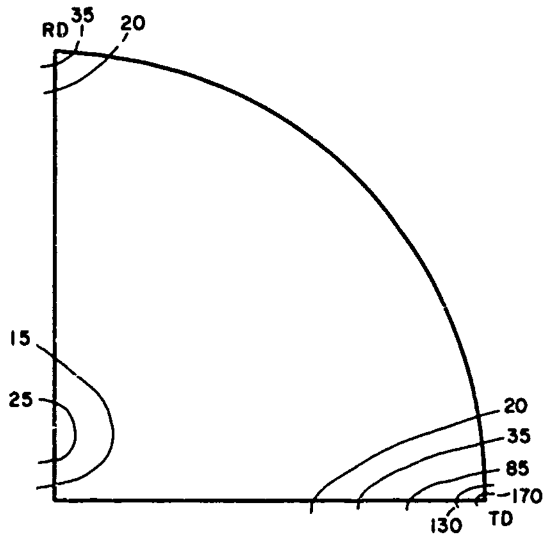
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (100X)

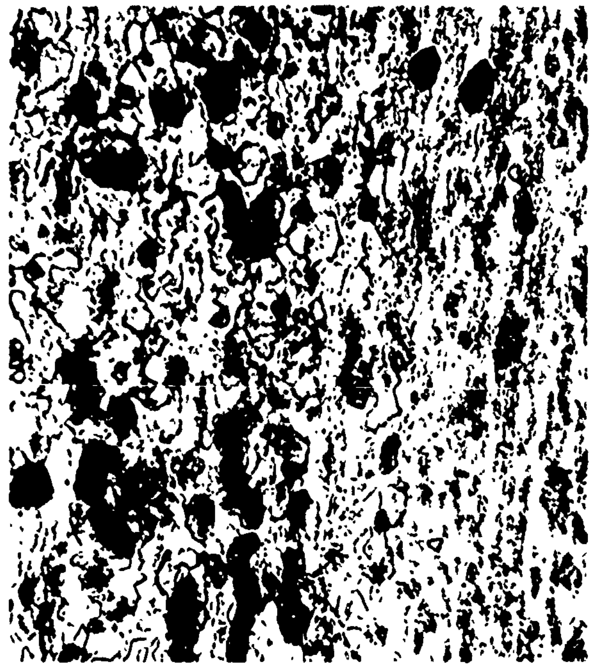
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.127	0.314	0.326	15.5	148,700	155,100	172,500	5.5
10	0.129	0.300	0.336	15.6	150,000	157,000	174,200	6.0
20	0.128	0.347	0.360	16.1	149,600	155,900	173,200	5.5
30	0.128	0.300	0.413	16.0	147,600	153,600	168,000	5.5
40	0.128	0.305	0.489	16.4	149,300	155,900	171,100	7.0
50	0.128	0.312	0.507	15.7	150,900	158,600	174,200	6.5
60	0.129	0.300	0.479	15.5	149,300	155,500	171,100	8.0
70	0.130	0.306	0.463	15.8	149,200	155,800	170,500	10.0
80	0.130	0.306	0.468	15.8	155,300	162,300	177,700	8.5
90	0.129	0.309	0.414	16.6	159,400	165,600	178,100	8.0

Ti-6Al-4V-M2803 (0.07 in)



(0002) POLE FIGURE

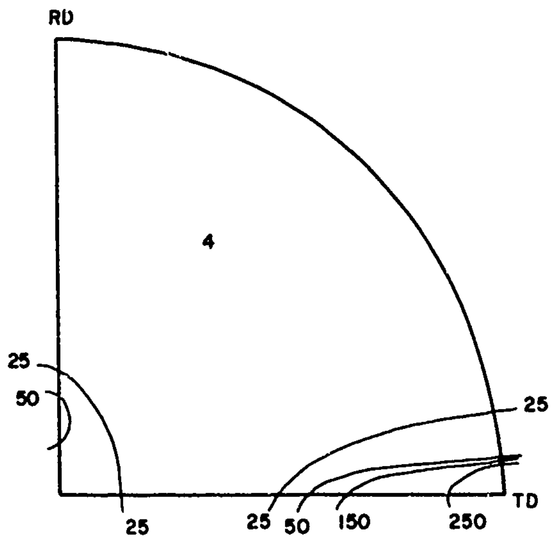


ETCHED MICROSTRUCTURE (1000X)

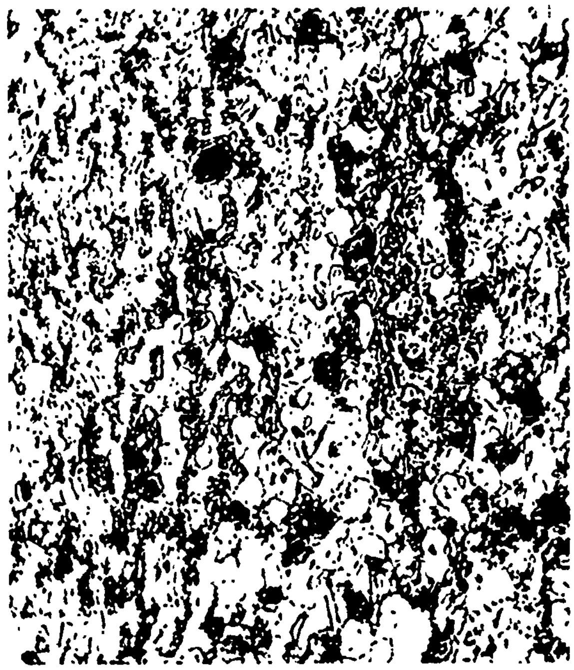
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.070	0.289	0.303	14.7	116,600	119,100	138,100	5.0
10	0.073	0.286	0.286	14.4	115,900	117,800	132,200	5.0
20	0.074	0.272	0.250	14.7	123,200	124,300	133,000	7.5
30	0.074	0.291	0.575	15.2	122,000	122,900	128,000	11.5
40	0.074	0.308	0.580	15.8	121,300	121,800	123,500	15.5
50	0.074	0.321	0.674	15.9	119,900	121,600	122,600	15.0
60	0.075	0.336	0.701	16.9	125,700	127,700	129,000	12.0
70	0.075	0.331	0.656	17.9	135,600	137,000	139,400	10.5
80	0.075	0.332	0.490	18.8	140,800	141,900	148,000	11.5
90	0.075	0.336	0.440	19.1	141,700	142,800	150,400	8.5

Ti-6Al-4V-M2803 (0.03 in)



(0002) POLE FIGURE

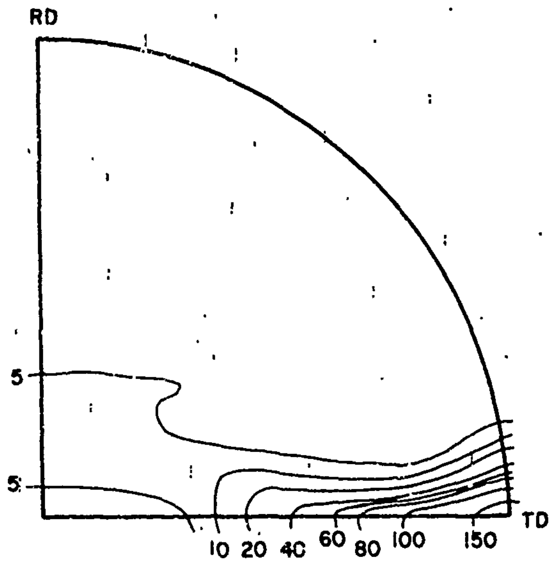


ETCHED MICROSTRUCTURE (1000X)

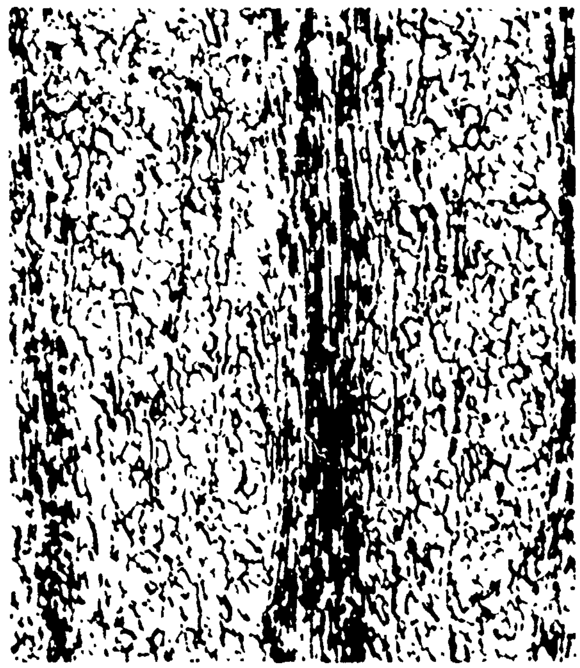
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10[6] Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.036	0.240	0.150	11.7	93,900	104,400	116,100	-
10	0.037	0.225	0.129	12.7	90,800	96,200	119,500	5.5
20	0.036	0.290	0.157	13.2	93,700	98,400	118,900	9.0
30	0.038	0.310	0.383	13.7	97,400	102,600	116,600	10.0
40	0.038	0.324	0.584	14.4	100,000	103,900	113,400	11.0
50	0.038	0.309	0.711	15.7	101,300	106,100	113,200	9.0
60	0.037	0.322	0.654	16.0	111,400	115,700	121,600	-
70	0.038	0.299	0.457	17.0	120,300	123,700	133,700	7.0
80	0.038	0.285	0.210	17.4	121,800	124,700	133,200	4.0
90	0.038	0.316	0.221	17.3	121,100	124,700	133,200	2.5

Ti-6Al-4V-M2803 (0.06 in)



(0002) POLE FIGURE

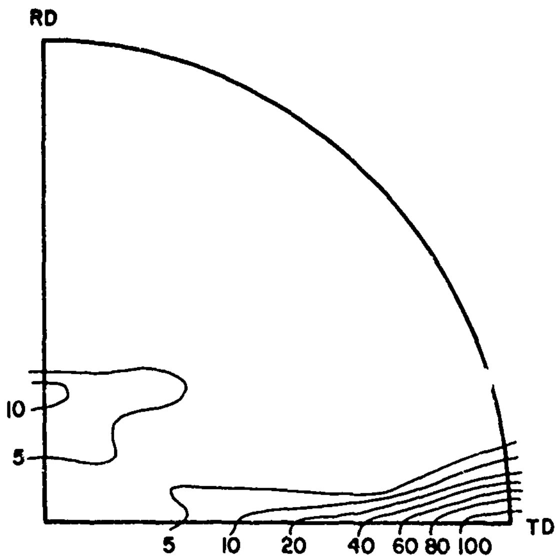


ETCHED MICROSTRUCTURE (1000X)

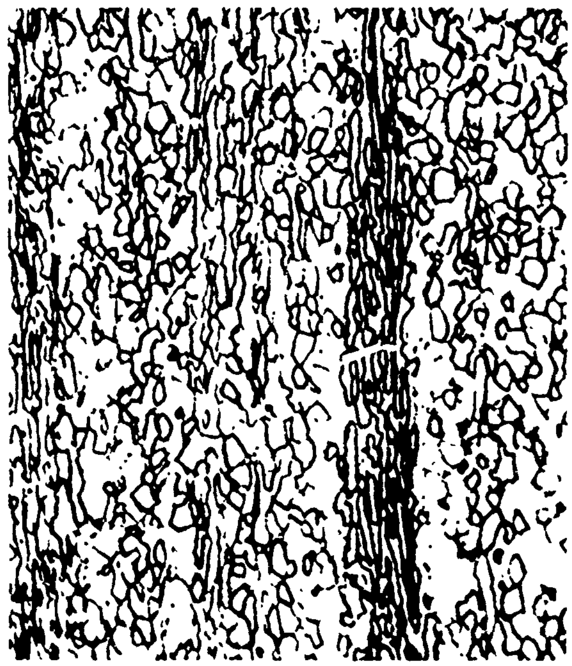
HEAT TREATMENT

Solution treated at 1450F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

Ti-6Al-4V-M2803 (0.06 in)



(0002) POLE FIGURE

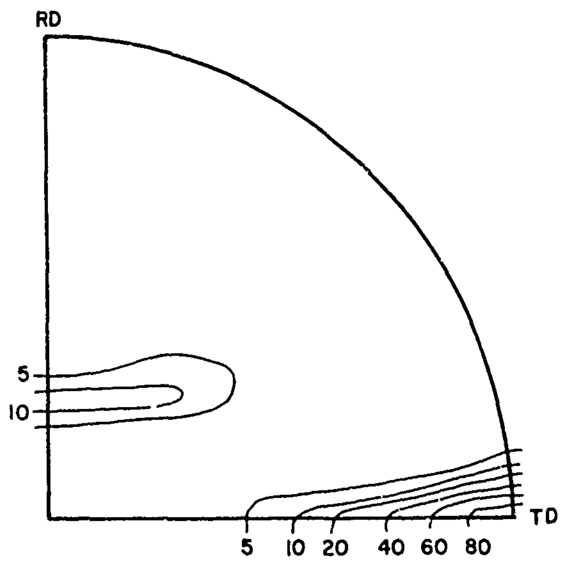


ETCHED MICROSTRUCTURE (1000X)

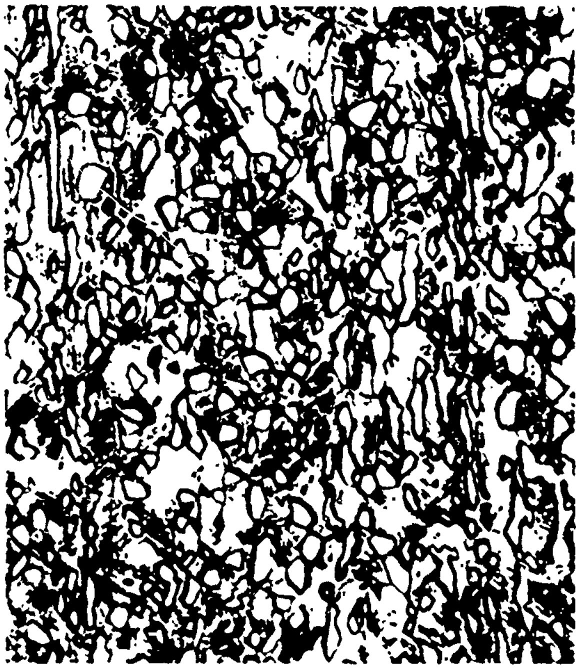
HEAT TREATMENT

Solution treated at 1550F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

Ti-6Al-4V-M2803 (0.06 in)



(0002) POLE FIGURE

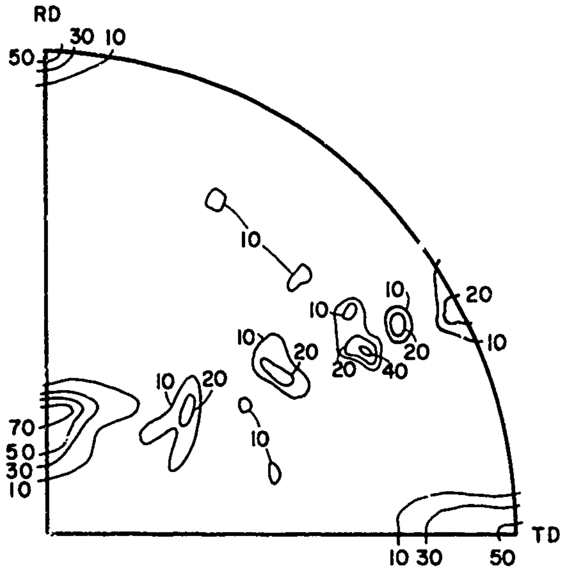


ETCHED MICROSTRUCTURE (1000X)

HEAT TREATMENT

Solution treated at 1650F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

Ti-6Al-4V-M2803 (0.06 in)



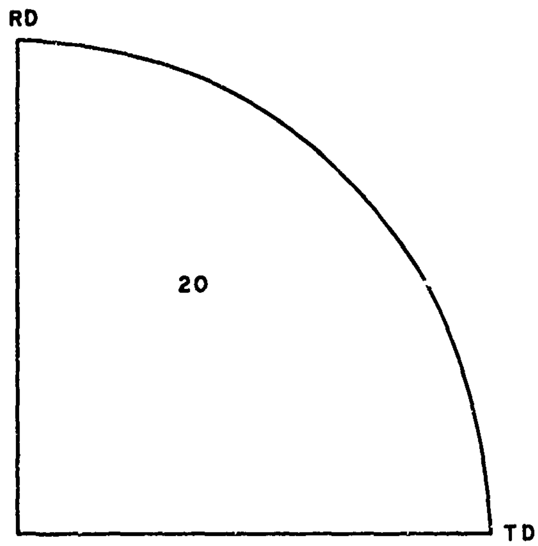
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

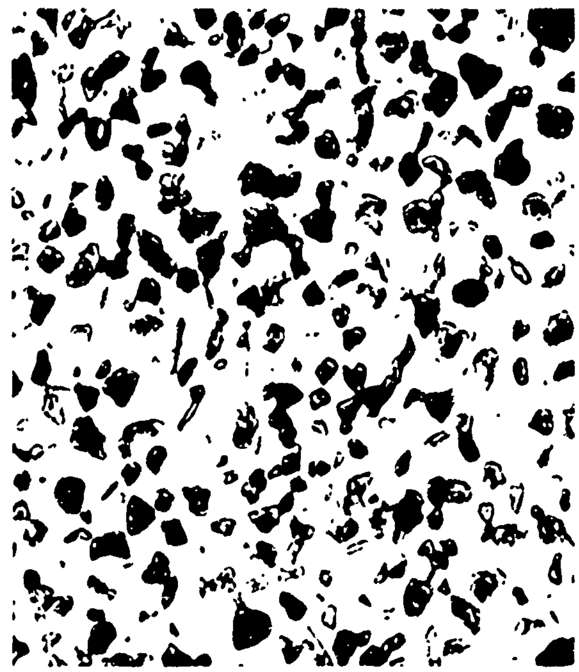
HEAT TREATMENT

Solution treated at 1750F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

Ti-6Al-4V-M27003



(0002) POLE FIGURE

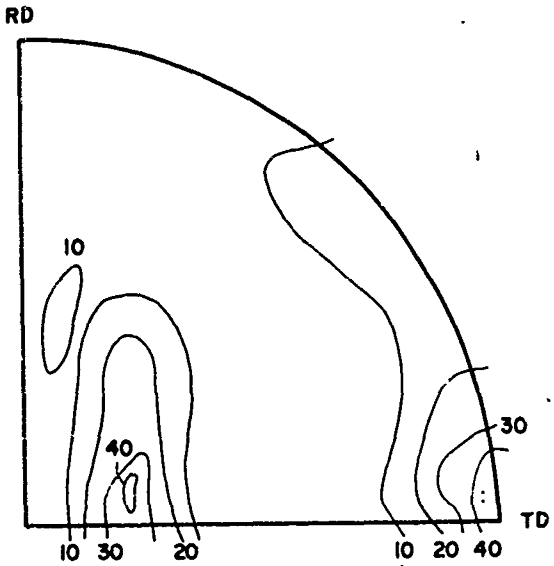


ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
L1	0.040	0.34	0.44	15.8	127,000	135,000	153,000
T1	0.040	0.36	0.48	14.8	123,000	128,800	141,000

Ti-6Al-4V-M27037



(0002) POLE FIGURE

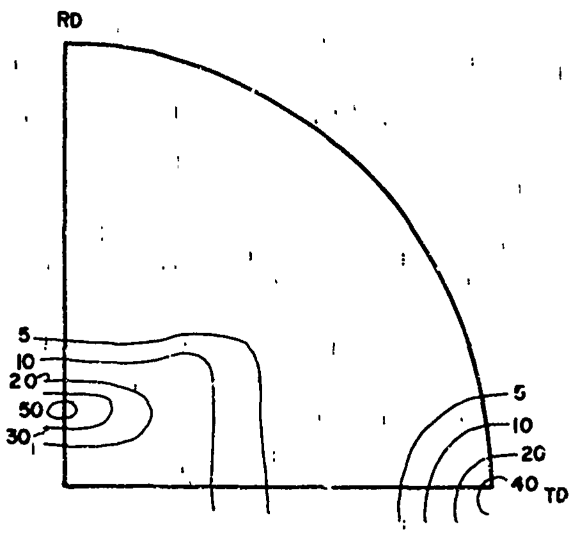
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

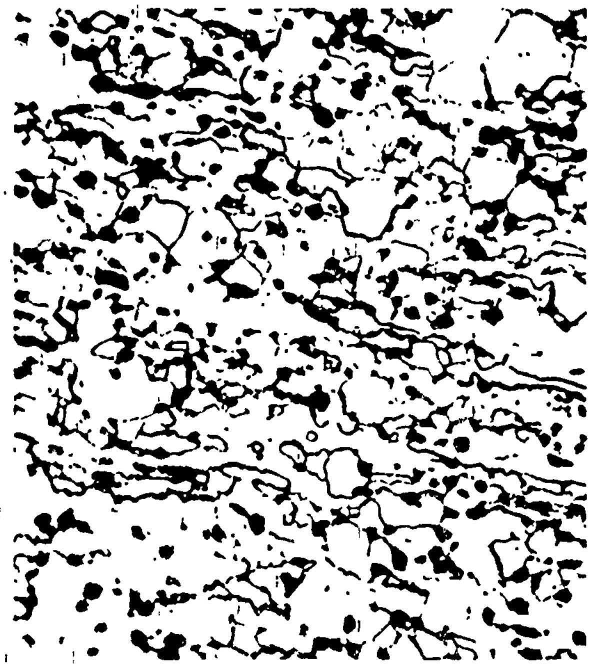
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_F	μ_p	Ex10[6] Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.037	0.318	*	15.4	121,600	128,600	154,600	10.0
10	0.038	0.308	0.322	14.5	119,500	126,300	155,800	11.5
20	0.038	0.311	0.458	14.6	188,400	126,300	152,600	11.0
30	0.038	0.341	0.441	15.0	122,400	129,500	153,200	10.0
40	0.038	0.316	0.593	15.5	122,600	130,500	153,100	7.5
50	0.038	0.320	0.403	15.0	117,400	124,700	151,600	10.5
60	0.039	311	0.618	14.2	119,500	125,600	149,200	13.0
70	0.038	0.329	0.331	15.5	125,800	134,200	157,400	10.0
80	0.038	0.326	0.376	15.4	127,000	134,400	157,100	12.0
90	0.038	0.329	0.504	15.6	124,300	132,300	155,600	11.5
100	0.038	0.353	0.441	15.5	128,900	135,800	157,400	11.5

*Premature gage failure

APPENDIX III
Ti-4Al-3Mo-1V-M8018



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

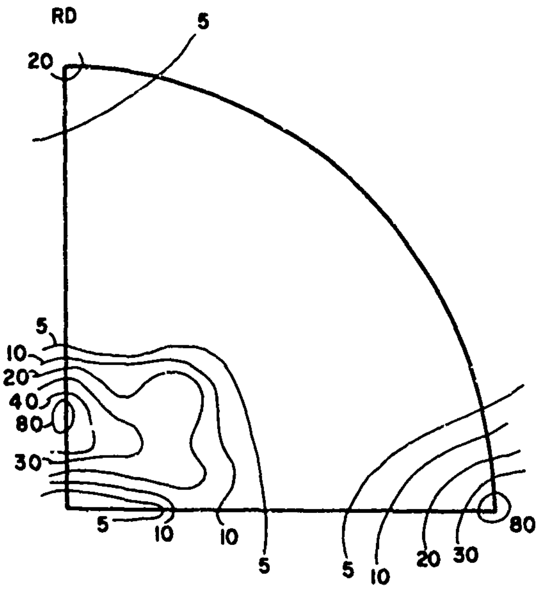
HEAT TREATMENT

Solution treated at 1400F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

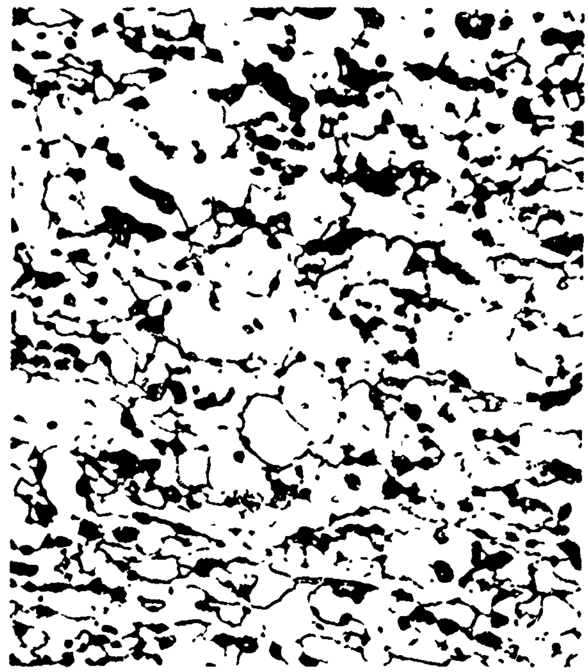
MECHANICAL PROPERTIES

Specimen Orientation	Thick-ness (inch)	μ_ε	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
L	0.064	0.300	0.444	16.1	113,200	116,400	135,200	14.0

Ti-4Al-3Mo-1V-M8018



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

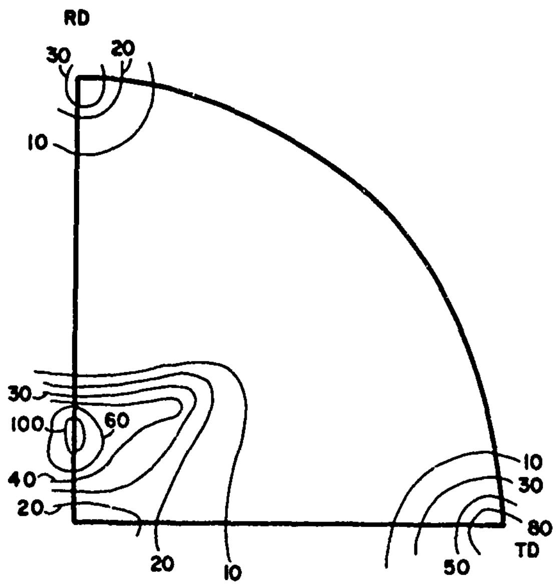
HEAT TREATMENT

Solution treated at 1500F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

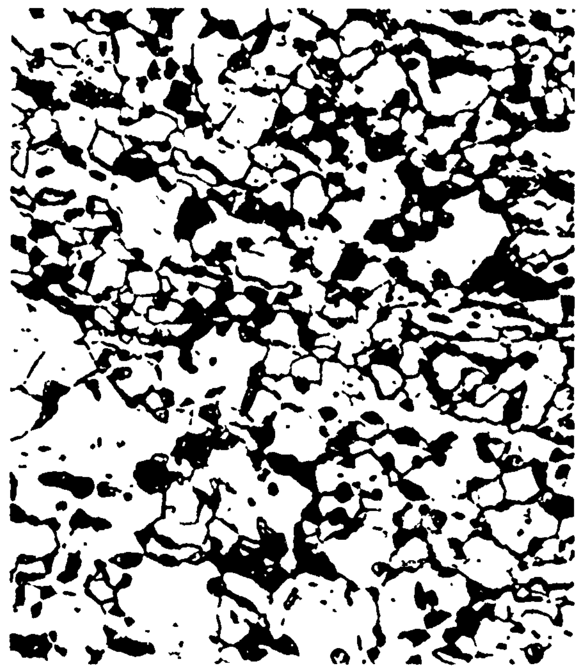
MECHANICAL PROPERTIES

Specimen Orientation	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
L	0.062	0.337	0.524	16.6	120,300	124,800	147,700	11.0

Ti-4Al-3Mo-1V-M8018



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

HEAT TREATMENT

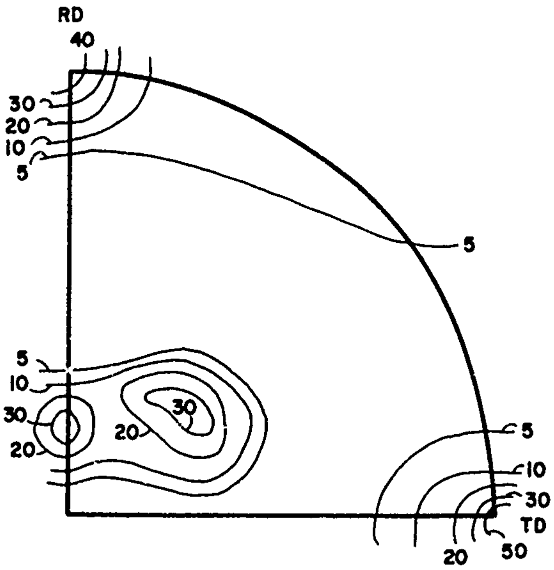
Solution treated at 1600F, 1/4 hr w.q.

Aged at 1000F, 1/4 hr ac

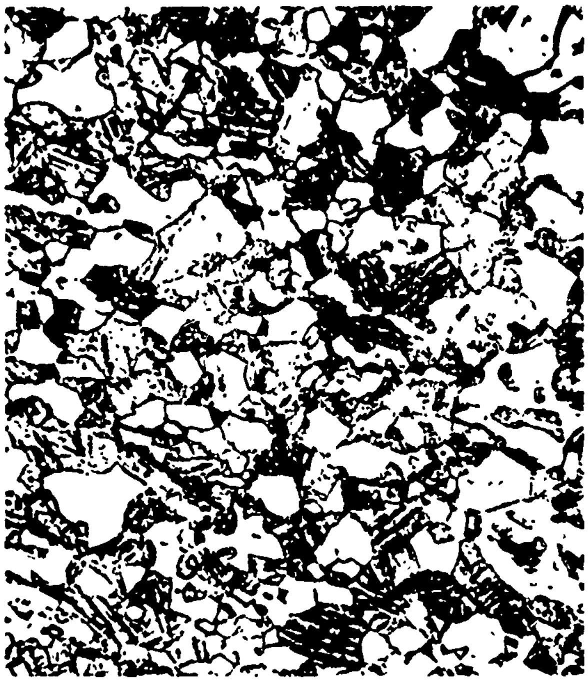
MECHANICAL PROPERTIES

Specimen Orientation	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
L	0.063	0.315	0.422	16.1	133,300	140,500	173,800	8.5

Ti-4Al-3Mo-1V-M8018



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

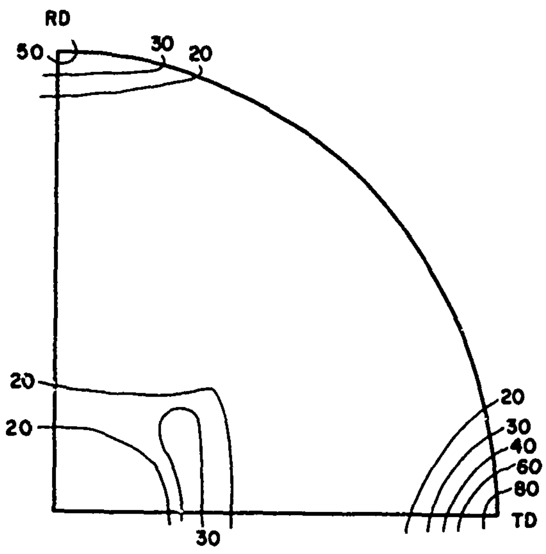
HEAT TREATMENT

Solution treated at 1700F, 1/4 hr w.q.
Aged at 1000F, 4 hr ac

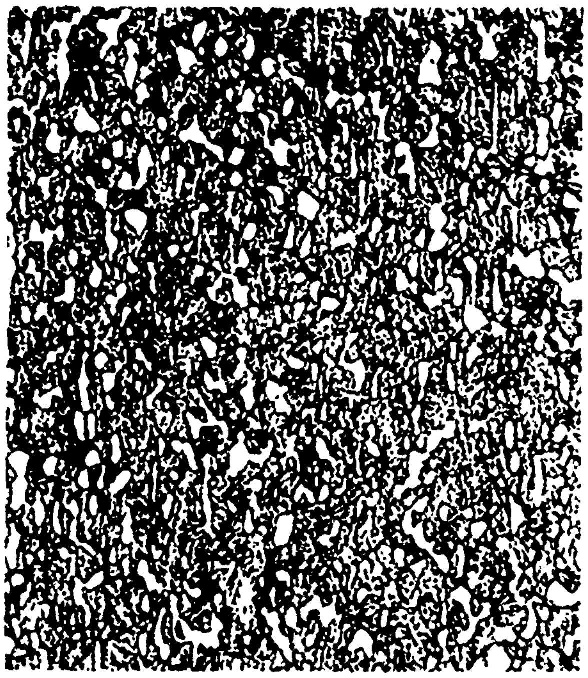
MECHANICAL PROPERTIES

Specimen Orientation	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
L	0.062	0.300	0.374	16.1	159,400	165,900	179,600	2.5

Ti-4Al-3Mo-1V-M8577



(0002) POLE FIGURE

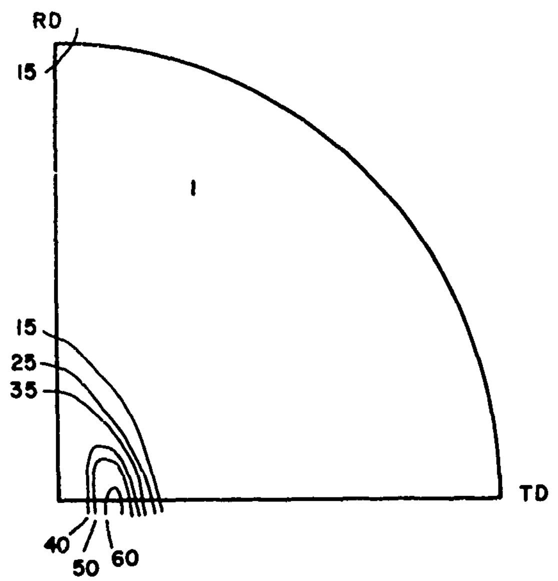


ETCHED MICROSTRUCTURE (1000X)

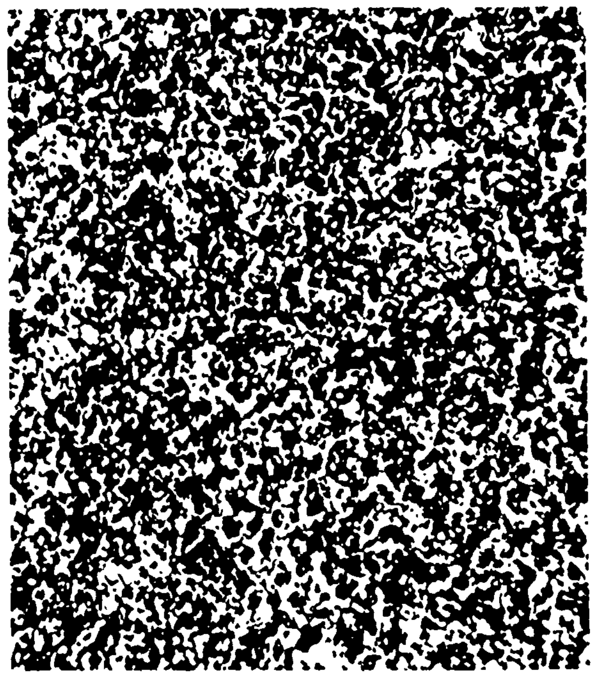
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.067	0.273	0.117	13.8	93,000	100,300	136,700	13.5
10	0.067	0.274	0.163	14.3	92,400	99,100	139,600	17.0
20	0.067	0.278	0.227	14.0	97,000	103,300	138,200	15.5
30	0.067	0.318	0.306	13.8	93,000	100,000	137,700	19.0
40	0.067	0.345	0.446	13.6	92,300	98,200	134,200	17.5
50	0.066	0.350	0.468	13.8	89,100	95,300	135,500	20.0
60	0.067	0.333	0.359	14.3	93,400	101,800	138,500	17.5
70	0.065	0.360	0.541	15.6	91,900	100,000	142,200	17.0
80	0.065	0.307	0.400	15.1	90,100	100,900	141,300	18.0
90	0.065	0.294	0.220	14.5	91,500	100,600	141,000	17.0

Ti-4Al-3Mo-1V-X70006



(0002) POLE FIGURE



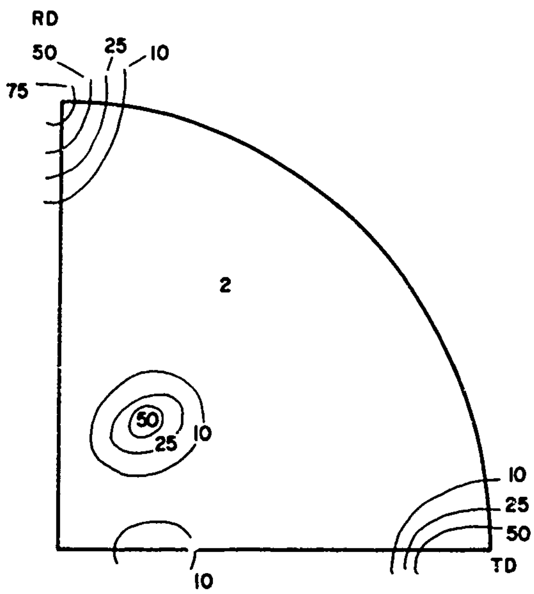
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

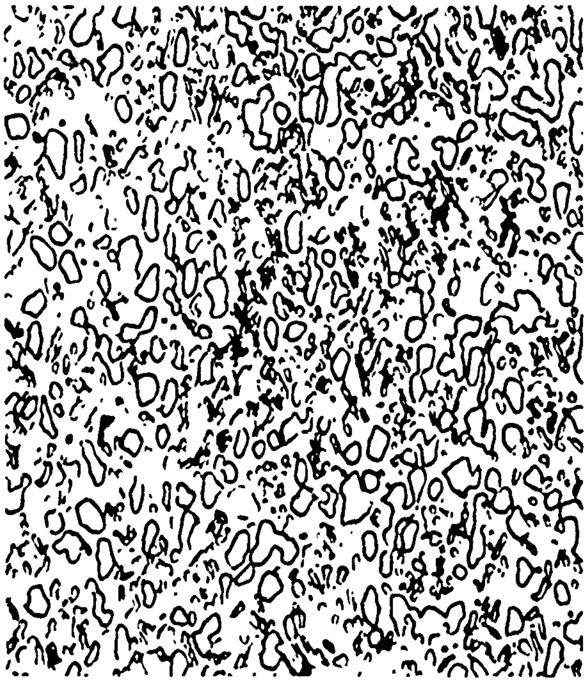
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E\times10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
0	0.060	0.39	*	15.4	100,000	100,300	101,700
10	No specimen made, lack of material						
20	0.060	0.48	0.96	14.9	99,700	99,000	99,700
30	No specimen made, lack of material						
40	0.062	0.43	0.91	15.0	97,400	97,100	97,400
50	0.060	0.46	1.23	15.1	98,700	98,700	98,700
60	0.060	0.45	0.96	15.4	100,000	100,000	100,000
70	0.060	0.43	0.95	15.2	100,000	100,000	100,000
80	0.058	0.44	*	16.2	103,800	104,800	103,800
90	0.060	0.43	0.42	16.1	105,300	104,700	105,000

*Premature gage failure

Ti-4Al-3Mo-1V-M8173



(0002) POLE FIGURE

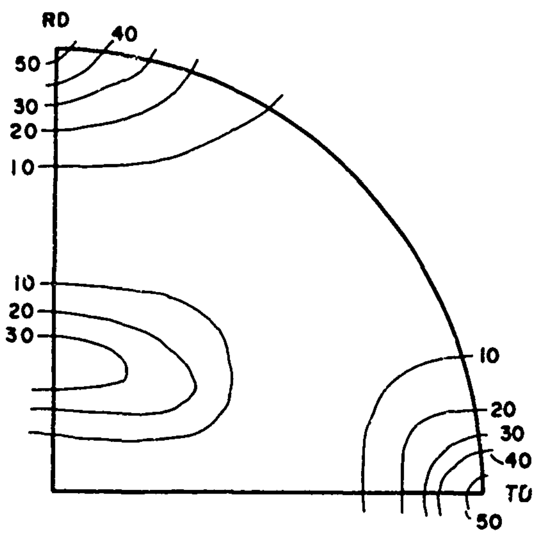


ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.021	0.243	0.060	13.0	68,600	76,200	130,950	13.0
10	0.021	0.267	0.066	10.3	69,700	79,300	133,650	12.0
20	0.021	0.276	0.178	12.6	64,900	75,000	139,900	13.5
30	0.022	0.328	0.271	12.2	68,200	76,800	139,500	14.5
40	0.021	0.339	0.416	13.6	75,700	84,300	146,700	15.0
50	0.022	0.389	0.362	14.1	71,800	81,400	140,450	16.5
60	0.022	0.346	0.365	14.1	80,450	90,450	146,400	16.0
70	0.022	0.339	0.299	13.8	88,200	97,300	149,500	15.0
80	0.022	0.314	0.189	14.4	90,900	102,700	147,300	13.5
90	0.022	0.340	0.271	13.9	95,000	105,900	147,700	12.0

APPENDIX IV
Ti-8Al-1Mo-1V-V1848



(0002) POLE FIGURE

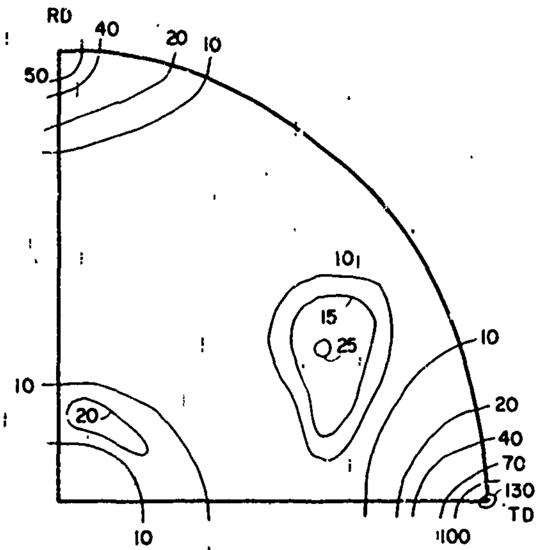
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

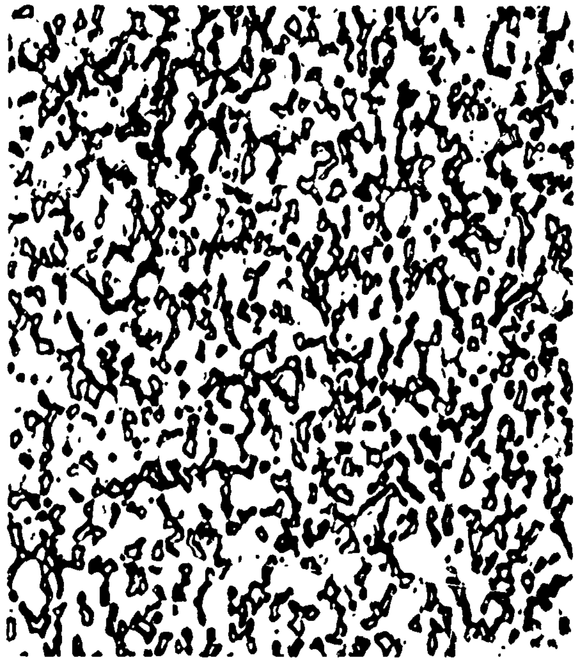
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E\times10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.129	0.308	0.332	18.4	143,200	142,700	150,600	19.5
10	0.130	0.313	0.435	18.3	142,700	142,500	149,800	19.0
20	0.131	0.315	0.463	18.2	137,300	137,100	143,200	20.0
30	0.131	0.321	0.535	18.0	134,400	134,400	138,300	19.5
40	0.132	0.303	0.588	17.3	130,100	130,300	133,900	16.5
50	0.129	0.300	0.506	17.5	134,100	134,300	137,800	16.0
60	0.130	0.300	0.362	17.2	135,200	135,300	140,100	19.5
70	0.131	0.299	0.621	17.4	136,600	135,600	141,900	19.0
80	0.130	0.293	0.450	17.3	139,200	138,200	147,300	17.5
90	0.131	0.283	0.356	17.2	138,000	137,000	144,800	16.5

APPENDIX V

Ti-6Al-6V-2Sn-S



(0002) POLE FIGURE



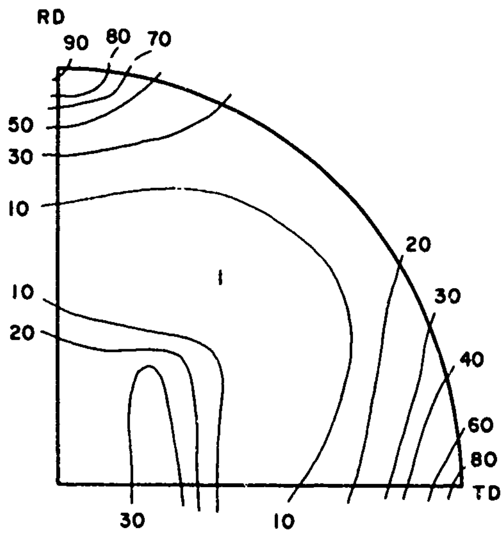
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

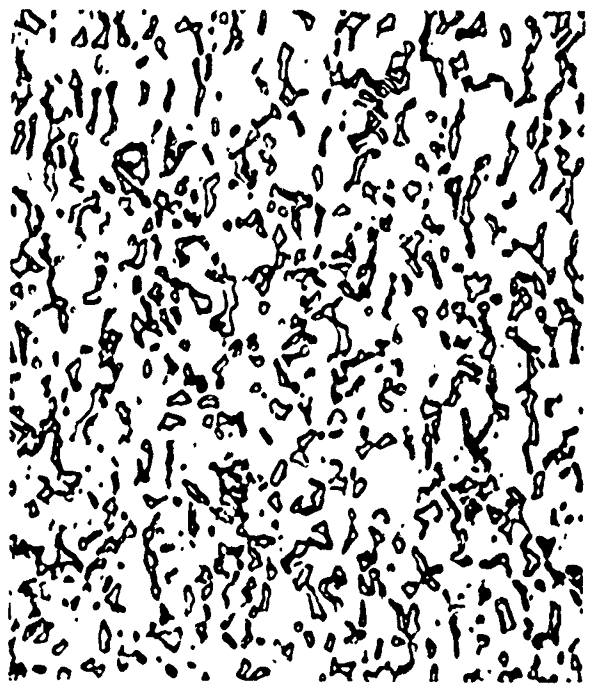
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
0	0.115	0.286	*	16.1	147,600	147,100	154,800
10	0.115	0.274	0.284	16.0	144,200	144,200	152,100
20	0.115	0.294	0.324	16.0	145,200	143,500	148,500
30	0.115	0.303	0.552	15.9	143,500	142,400	143,500
40	0.115	0.302	0.485	15.8	136,000	136,000	136,900
50	0.115	0.310	0.571	16.2	138,400	138,400	138,400
60	0.115	0.314	0.577	16.4	141,900	141,900	142,300
70	0.115	0.303	0.655	16.8	145,100	146,000	151,700
80	0.115	0.290	0.250	16.9	145,700	145,700	152,200
90	0.115	0.296	0.326	17.2	150,200	149,800	158,800

*Premature gage failure

Ti-6Al-6V-2Sn-H



(0002) POLE FIGURE

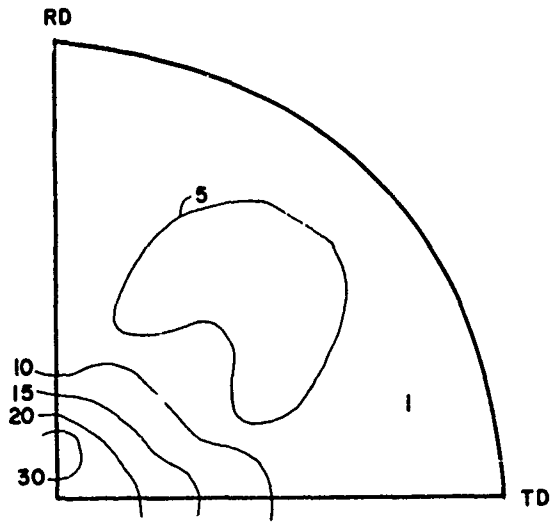


ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
0	0.115	0.310	0.412	16.2	159,000	159,800	167,500
10	0.115	0.294	0.327	16.3	159,500	159,500	166,300
20	0.115	0.307	0.372	16.2	158,200	157,000	162,000
30	0.115	0.312	0.488	16.0	153,900	153,900	155,900
40	0.115	0.318	0.559	15.8	150,600	150,600	151,900
50	0.115	0.320	0.571	15.8	150,000	150,000	150,200
60	0.115	0.315	0.517	16.2	151,600	151,600	153,800
70	0.115	0.308	0.419	16.8	157,600	157,600	161,000
80	0.115	0.306	0.333	17.0	160,200	160,500	168,300
90	0.115	0.292	0.312	17.1	159,500	159,500	167,200

APPENDIX VI
Ti-8Mn-3442



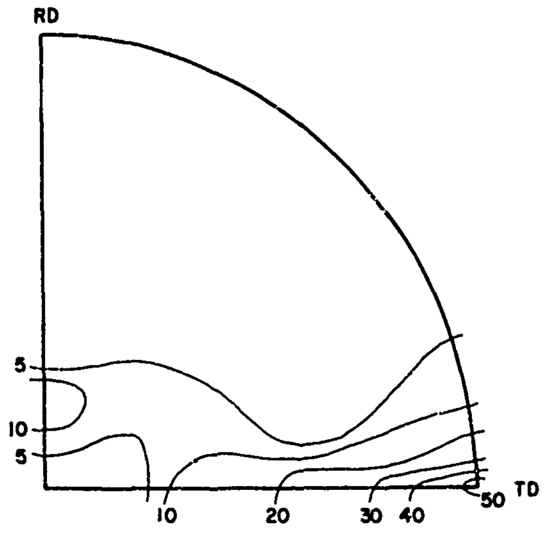
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
10	0.063	0.313	0.33	16.0	103,400	115,600	135,000
20	0.063	0.317	0.40	16.9	110,900	120,700	134,900
30	0.063	0.324	0.46	16.0	112,800	122,400	134,200
40	0.063	0.329	0.55	16.4	114,800	122,000	130,300
50	0.063	0.354	0.80	16.6	123,300	131,100	135,000
60	0.063	0.340	0.67	17.0	133,300	140,800	149,500
70	0.063	0.333	0.52	16.9	141,400	145,600	151,800
80	0.063	0.345	0.56	17.4	138,000	143,200	151,000
90	0.063	0.347	0.56	17.2	141,600	145,500	153,400
100	0.063	0.333	0.50	16.9	141,900	146,100	153,400
110	0.063	0.351	0.56	17.2	140,400	145,700	152,900
120	0.063	0.338	0.55	16.6	140,800	146,500	153,300
130	0.063	0.343	0.76	16.6	126,400	134,400	139,200
140	0.063	0.338	0.53	16.2	115,700	122,300	128,500
150	0.063	0.343	0.51	16.2	113,600	124,200	134,700
160	0.063	0.325	0.42	16.2	104,700	115,800	131,300
170	0.063	0.393	0.31	16.6	116,000	124,800	138,400
180	0.063	0.312	0.42	15.2	105,700	-	-

Ti-8Mn-A3613



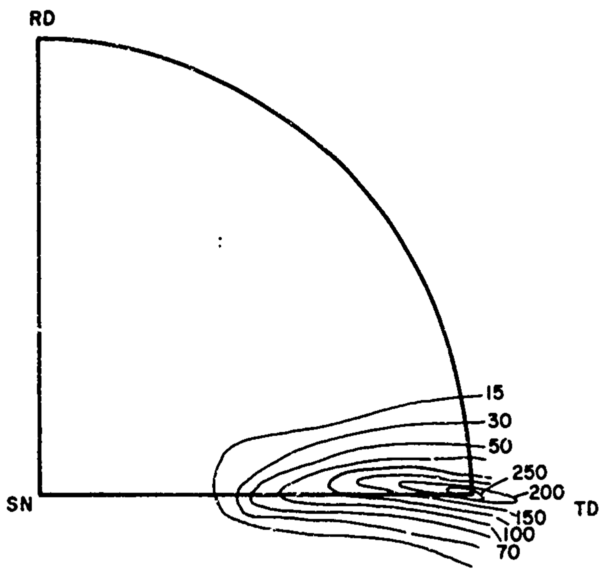
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.064	0.316	0.492	15.9	130,800	135,800	149,400	24.0
10	0.064	0.319	0.466	16.2	130,800	135,500	147,700	24.3
20	0.064	0.317	0.474	15.7	129,000	133,500	139,400	[illegible]
30	0.064	0.335	0.522	15.2	125,400	131,600	139,400	28.0
60	0.063	0.349	0.588	16.1	134,200	137,700	140,000	24.5
70	0.063	0.334	0.472	16.8	138,600	141,100	146,000	24.0
80	0.063	0.320	0.434	16.6	140,000	142,900	149,200	12.0
90	0.063	0.318	0.410	16.6	140,600	143,300	149,500	15.0

Ti-8Mn-A5227-7



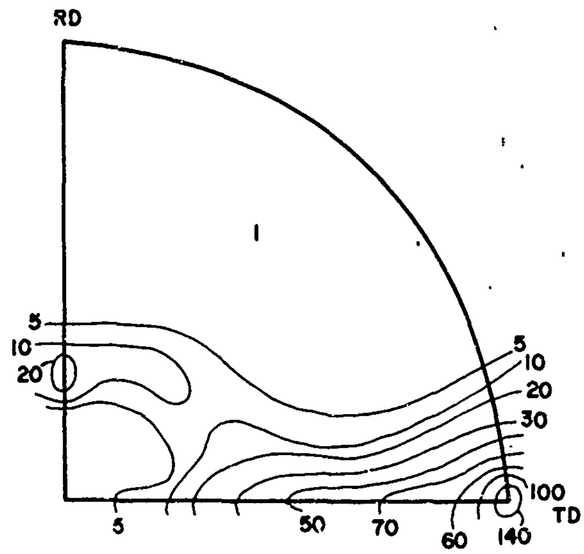
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

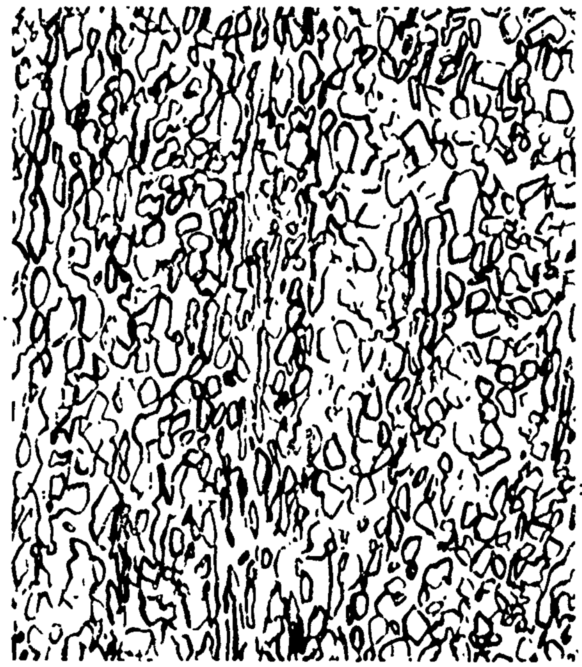
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)
10	0.032	0.288	-	16.6	114,300	117,500	133,100
20	0.032	0.305	0.255	16.0	113,600	117,500	128,600
30	0.032	0.308	0.372	16.6	111,400	115,300	119,500
40	0.032	0.349	0.527	15.6	114,900	116,600	116,900
50	0.032	0.338	0.587	16.2	119,300	121,300	123,000
60	0.032	0.327	0.569	16.5	129,000	132,000	132,000
70	0.032	0.304	0.407	18.0	141,300	141,300	145,300
80	0.032	0.30[illegible]	0.415	19.0	136,700	138,700	152,000
90	0.032	0.327	0.500	20.6	132,000	135,000	
100	0.032	0.323	0.517	19.6	131,300	135,300	144,000
110	0.032	0.333	0.585	17.4	130,300	134,200	141,900
120	0.032	0.322	0.559	16.5	130,600	124,500	130,600
130	0.032	0.348	0.590	16.5	127,900	131,200	134,400
140	0.032	0.327	0.463	16.2	120,000	123,700	131,900
150	0.032	0.321	0.432	16.6	118,800	123,100	135,900
160	0.032	0.325	0.410	16.9	127,500	131,200	145,000
170	0.032	0.311	0.339	15.5	115,300	120,600	134,100

Ti-8Mn-A5221-16



(0002) POLE FIGURE



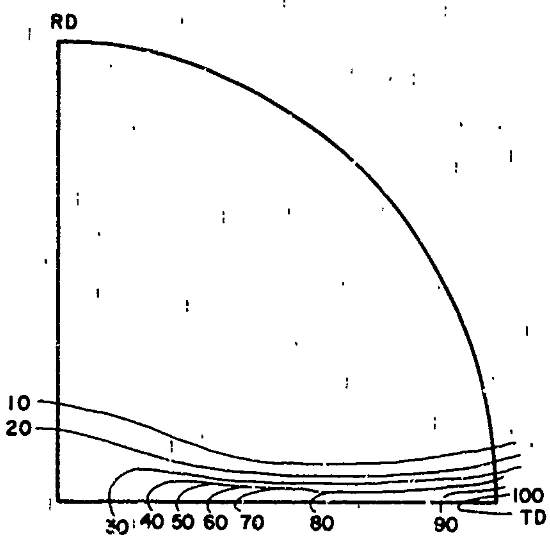
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

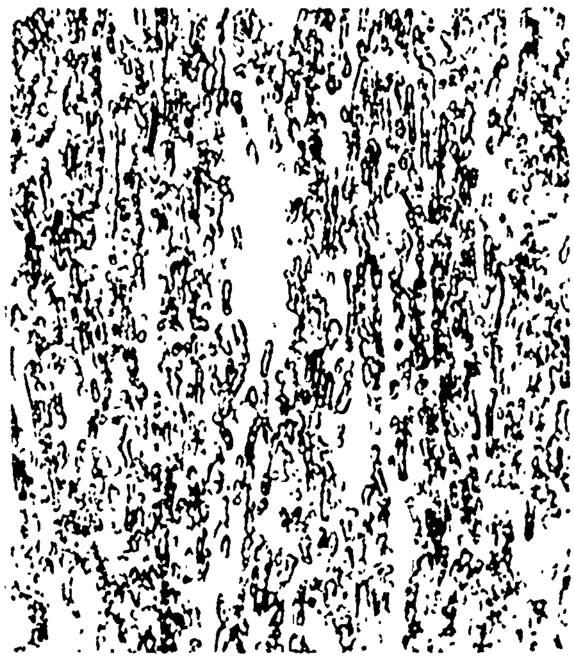
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.122	0.286	0.252	16.1	118,000	120,200	137,700	22.5
10	0.122	0.286	0.264	16.4	118,000	120,000	137,700	24.5
20	0.122	0.306	0.341	16.4	120,300	123,000	134,400	22.5
30	0.122	0.320	0.400	15.7	119,500	120,200	127,700	26.0
40	0.122	0.333	0.568	16.4	119,700	120,700	124,600	28.5
50	0.122	0.333	0.615	15.9	121,700	123,400	126,200	26.5
70	0.122	0.326	0.428	17.6	132,700	134,400	142,700	25.5
80	0.122	0.303	0.368	17.9	130,900	132,600	147,100	15.0
90	0.122	0.338	0.401	18.3	139,300	139,900	148,800	8.8

APPENDIX VII

Ti-4Al-4Mn-B3319-2



(0002) POLE FIGURE

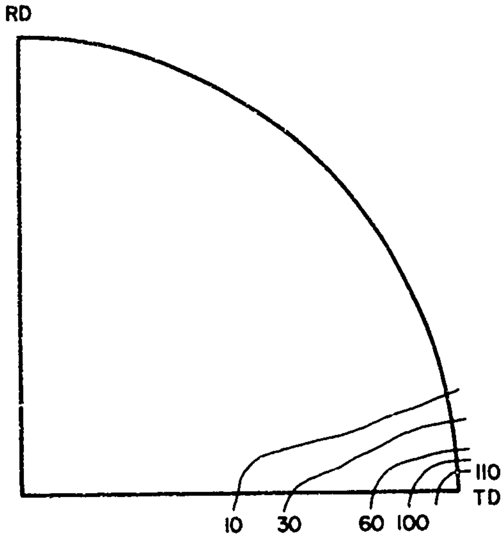


ETCHED MICROSTRUCTURE (1000X)

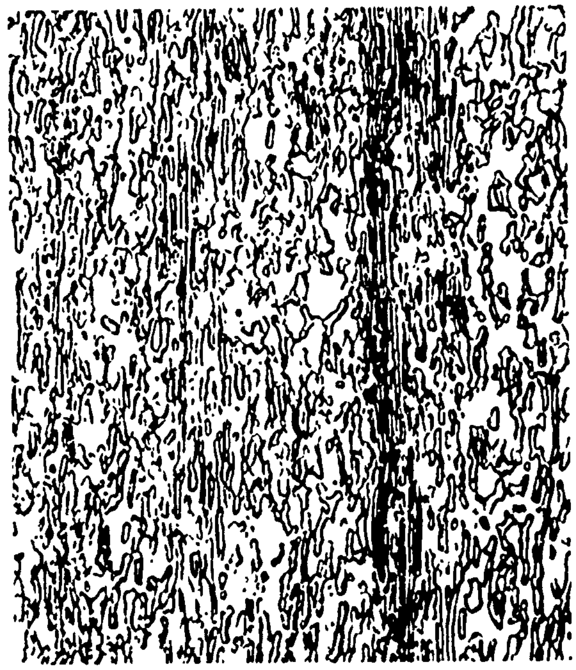
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.061	0.291	0.313	16.1	140,500	142,500	163,400	15.0
10	0.063	0.236	0.295	16.0	134,200	136,700	156,500	20.0
20	0.063	0.296	0.411	16.4	137,700	139,600	152,500	20.0
30	0.064	0.303	0.447	15.9	142,200	143,300	144,900	18.5
40	0.064	0.326	0.521	16.4	144,500	145,600	145,600	18.0
50	0.063	0.325	0.583	17.2	142,900	143,500	143,500	12.5
60	0.063	0.334	0.754	17.3	151,900	152,500	152,500	12.5
70	0.063	0.330	0.704	18.2	161,700	163,000	163,000	11.0
80	0.063	0.330	0.415	19.0	167,100	167,700	167,700	16.0
90	0.063	0.328	0.330	19.8	168,000	168,800	169,000	13.0

Ti-4Al-4Mn-B3263-B1



(0002) POLE FIGURE

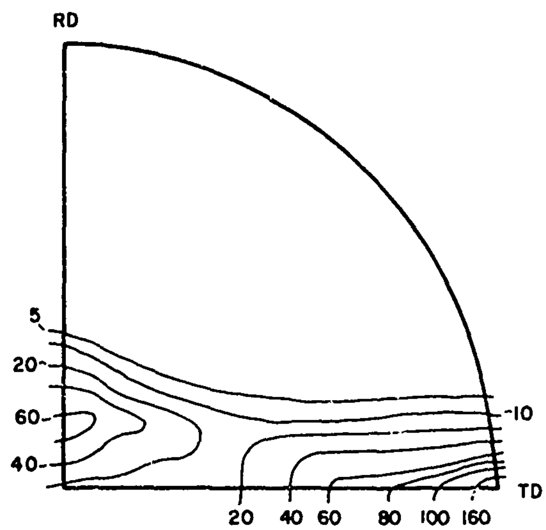


ETCHED MICROSTRUCTURE (1000X)

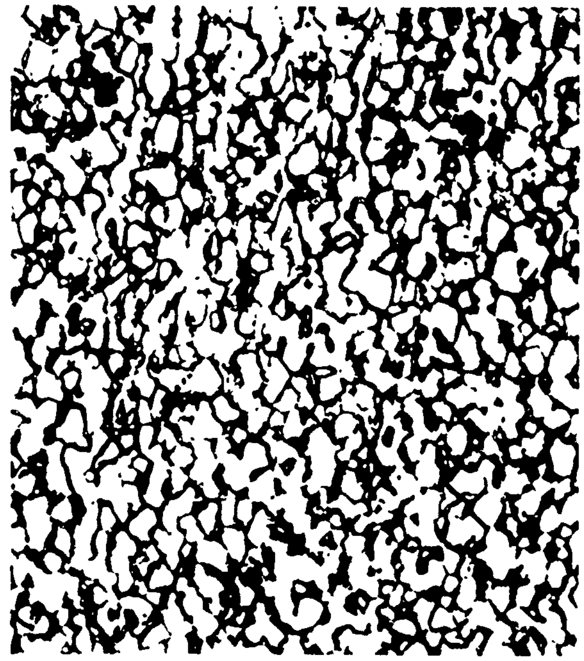
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.051	0.240	0.092	16.1	134,800	134,400	156,250	13.5
10	0.052	0.267	0.239	16.3	135,200	135,800	152,500	14.5
20	0.052	0.264	0.171	16.2	136,200	136,500	146,300	16.5
30	0.053	0.281	0.153	16.3	137,900	137,900	138,100	18.5
40	0.053	0.305		17.0	140,600	139,800	140,600	22.0
50	0.053	0.317	0.610	17.2	143,600	143,600	143,600	15.0
60	0.054	0.308	0.767	17.9	148,300	148,700	148,700	11.5
70	0.054	0.308	0.653	19.2	159,500	158,300	155,600	15.0
80	0.054	0.308	0.368	19.1	162,100	162,100	166,400	15.5
90	0.054	0.321	0.389	19.6	166,000	165,500	169,800	14.0
0	0.052	0.262	0.273	16.8	132,700	134,200	152,300	12.5
10	0.051	0.289	0.304	16.7	129,000	130,200	146,300	15.5
20	0.051	0.288	0.344	17.3	130,900	131,600	141,400	19.5
30	0.052	0.308	0.483	17.1	133,900	133,900	134,100	17.0
40	0.052	0.297	0.377	16.2	138,300	138,300	138,300	19.0
60	0.053	0.325	*	18.1	148,700	147,900	148,900	9.0
80	0.054	0.316	0.833	19.4	157,800	158,300	159,600	14.5
90	0.052	0.308	0.529	19.7	162,800	162,600	166,700	14.5

Ti-4Al-4Mn-B3263-B1



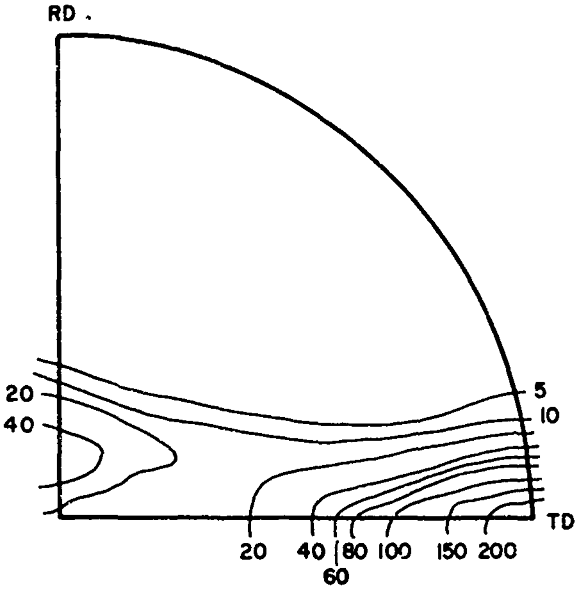
(0002) POLE FIGURE


ETCHED MICROSTRUCTURE (1000X)

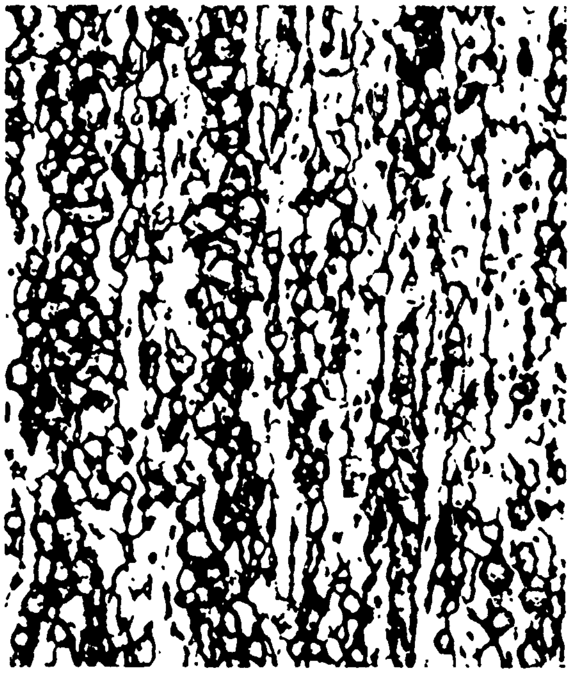
HEAT TREATMENT

Solution treated at 1300F, 3/4 hr w.q.
Aged at 1000F, 8 hr ac

Ti-4Al-4Mn-B3263-B1



(0002) POLE FIGURE

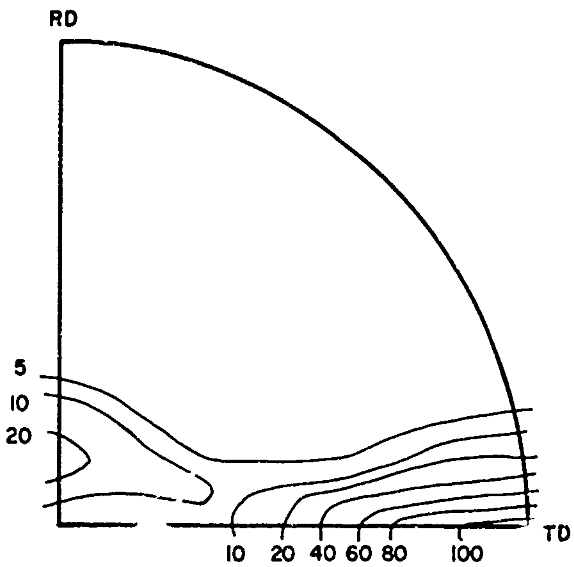


ETCHED MICROSTRUCTURE (1000X)

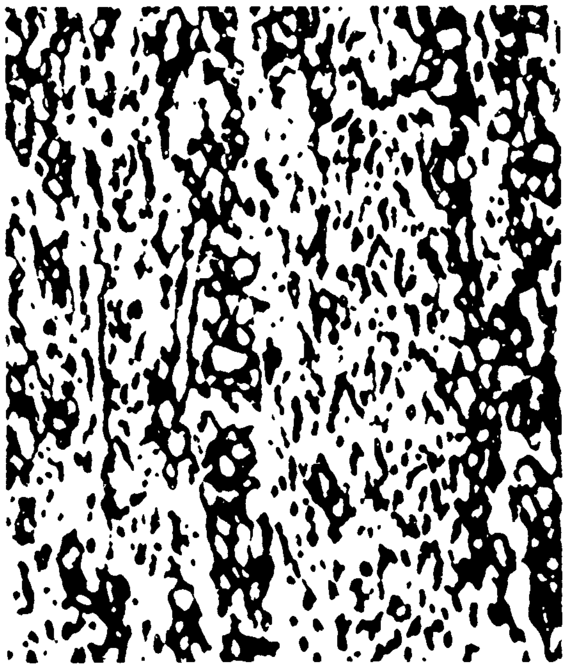
HEAT TREATMENT

Solution treated at 1400F, 3/4 hr w.q.
Aged at 1000F, 8 hr ac

Ti-4Al-4Mn-B3263-B1



(0002) POLE FIGURE

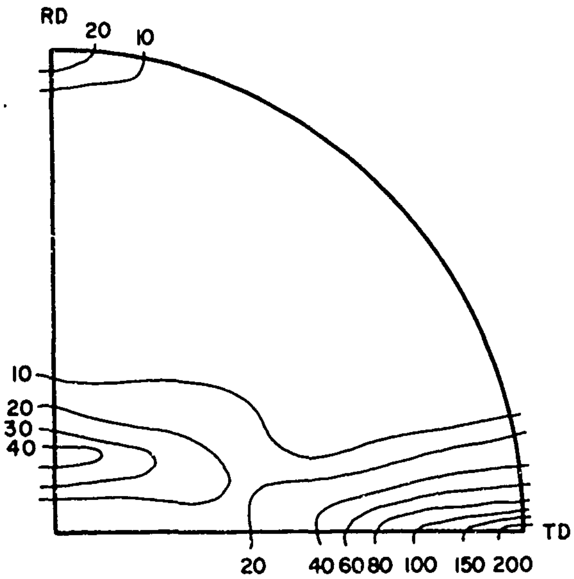


ETCHED MICROSTRUCTURE (1000X)

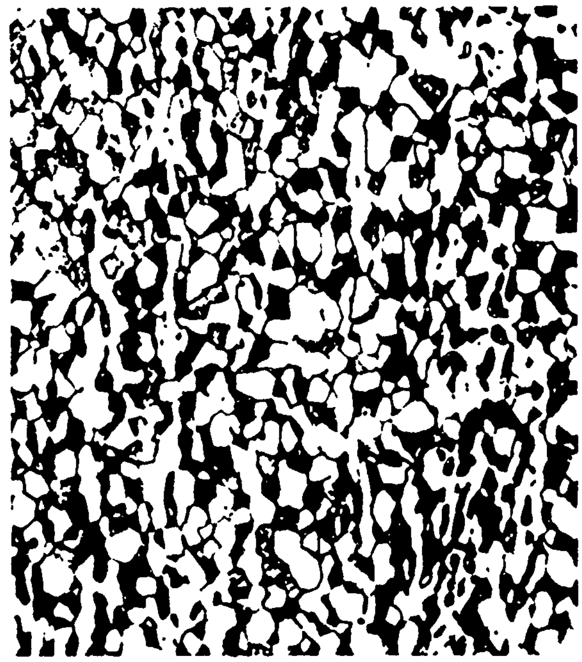
HEAT TREATMENT

Solution treated at 1500F, 3/4 hr w.q.
Aged at 1000F, 8 hr ac

Ti-4Al-4Mn-B3263-B1



(0002) POLE FIGURE

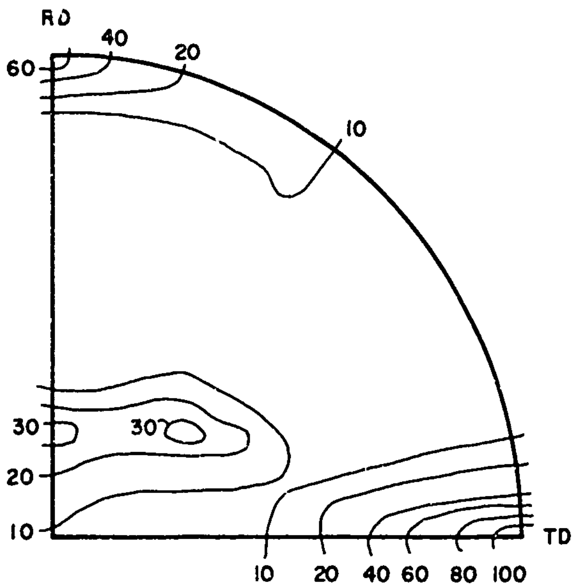


ETCHED MICROSTRUCTURE (1000X)

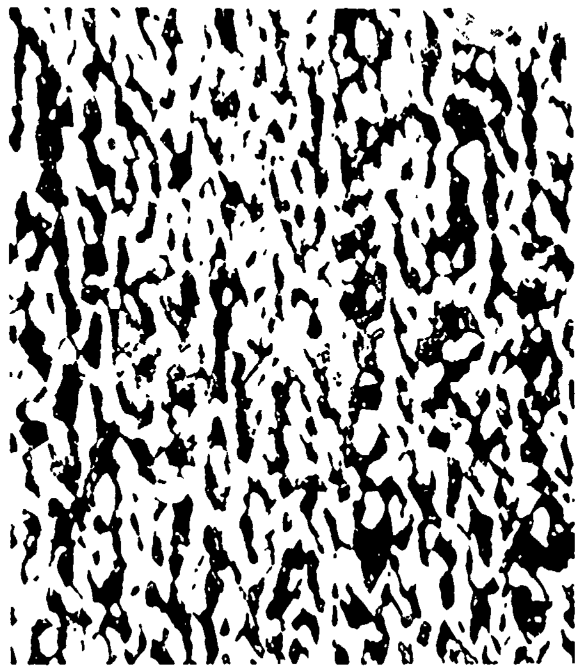
HEAT TREATMENT

Solution treated at 1600F, 3/4 hr w.q.
Aged at 1000F, 8 hr ac

Ti-4Al-4Mn-B3263-B1



(0002) POLE FIGURE

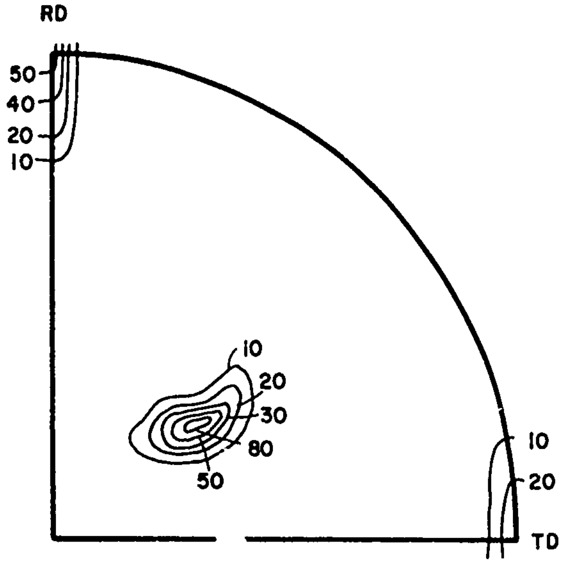


ETCHED MICROSTRUCTURE (1000X)

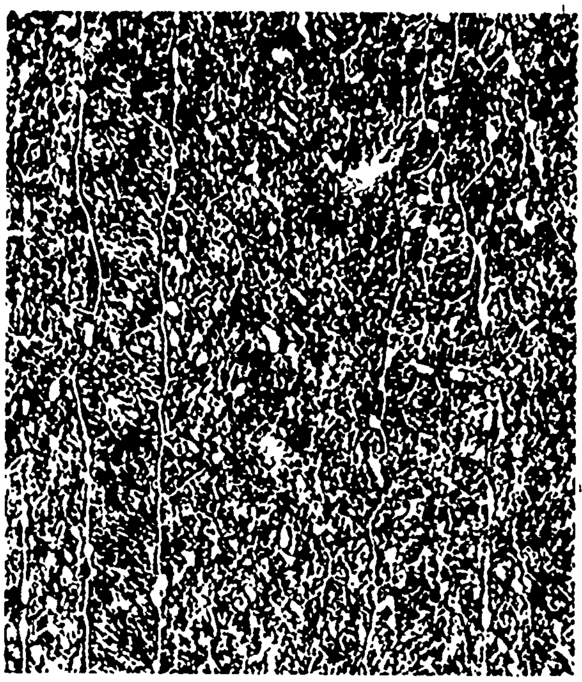
HEAT TREATMENT

Solution treated at 1700F, 3/4 hr w.q.
Aged at 1000F, 8 hr ac

APPENDIX VIII
Ti-16V-2.5Al-B24814



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1500X)

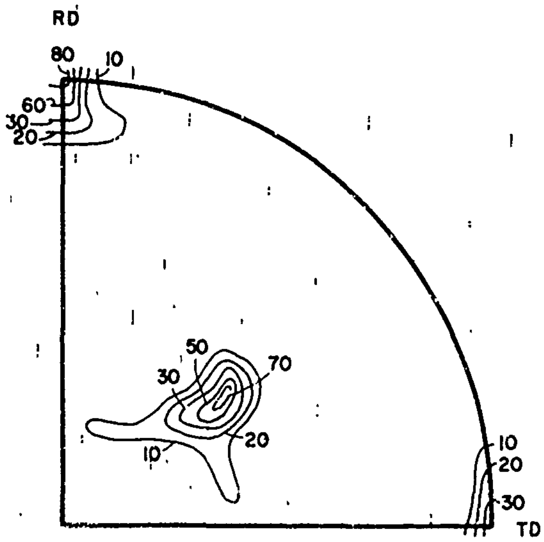
HEAT TREATMENT

Solution treated at 1200F, 1/2 hr w.q.
Aged at 975F, 4 hr ac

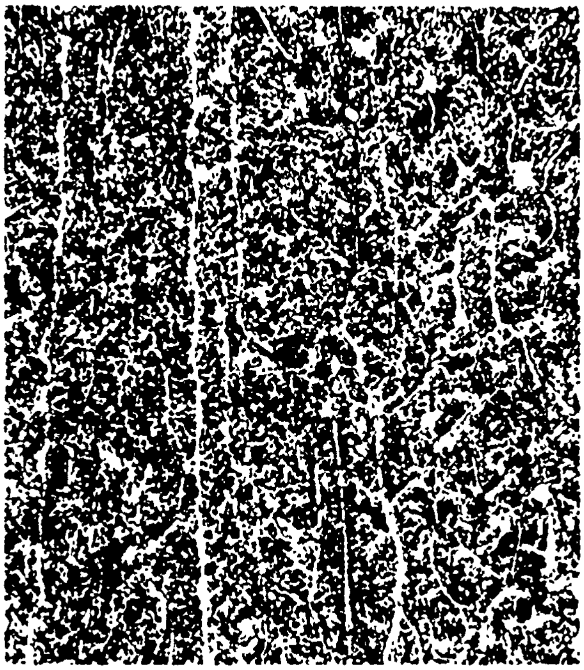
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
AT-4	0.026	0.278	0.152	15.5	127,700	130,000	138,800	2.5
AL-4	0.028	0.342	0.077	16.2	113,500	116,700	120,200	1.0

Ti-16V-2.5Al-B24814



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1500X)

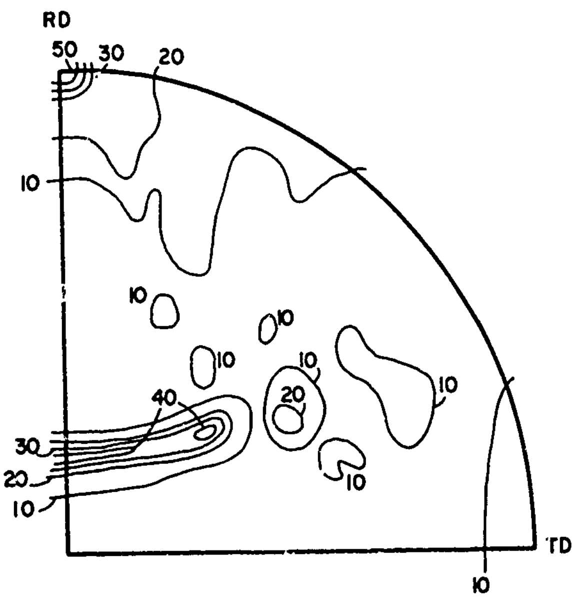
HEAT TREATMENT

Solution treated at 1300F, 1/2 hr w.q.
Aged at 975F, 4 hr ac

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
AT-6	0.028	0.261	0.152	15.5	142,100	145,000	158,900	6.0
AL-6	0.027	0.258	0.140	15.7	141,900	145,200	152,200	2.5

Ti-16V-2.5Al-B24814



(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1500X)

HEAT TREATMENT

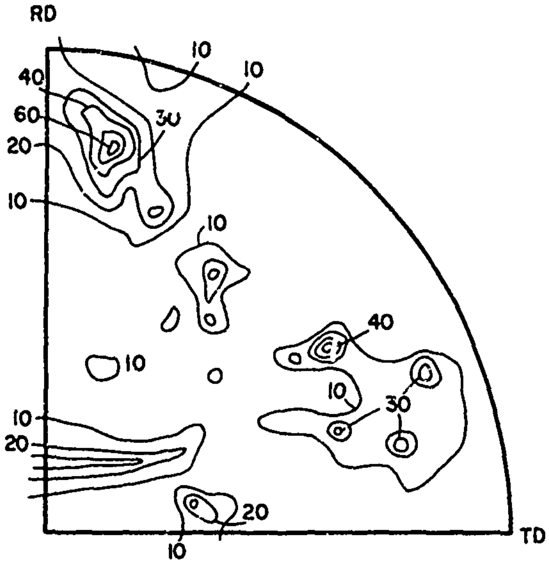
Solution treated at 1400F, 1/2 hr w.q.
Aged at 975F, 4 hr ac

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	[illegible]	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
AT-8	0.028	[illegible]	[illegible]	15.0	166,100	171,400	180,700	1.5
AL-8	0.028	[illegible]	[illegible]14	15.0	-	-	-	0

*Premature gage failure

Ti-16V-2.5Al-B24814



(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

HEAT TREATMENT

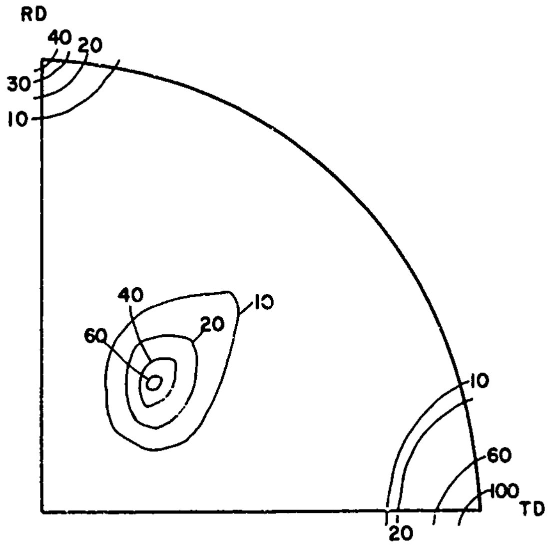
Solution treated at 1450F, 1/2 hr w.q.
Aged at 975F, 4 hr ac

MECHANICAL PROPERTIES

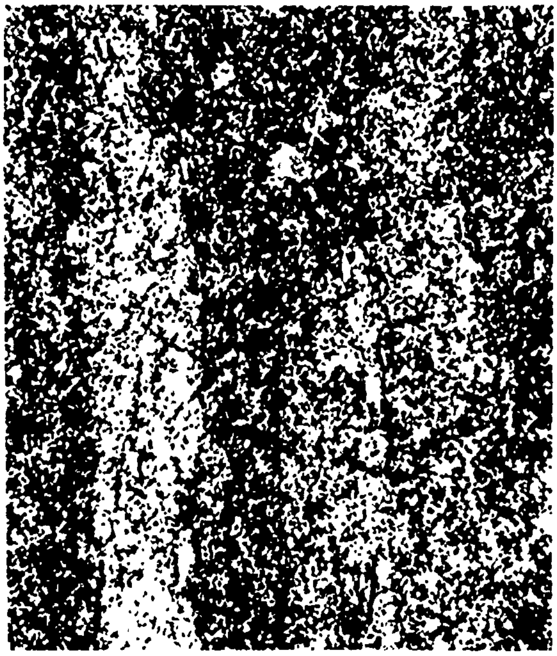
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
AT-3	0.028	0.311	*	14.9	160,700	170,700	182,500	3.5
AL-3	0.028	0.344	*	14.2	162,200	168,000	174,800	1.5

*Premature gage failure

Ti-16V-2.5Al-B24814



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

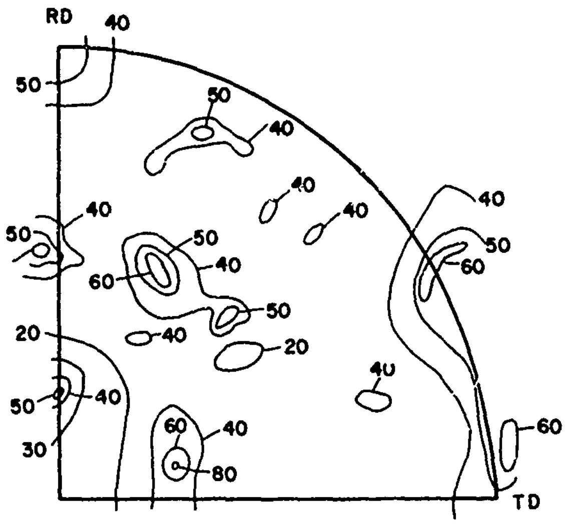
HEAT TREATMENT

Aged at 975F, 4 hr ac

MECHANICAL PROPERTIES

Specimen Orientation (deg)	Thick-ness (inch)	μ_E	μ_p	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
[illegible]	0.028	0.250	0.111	14.8	159,600	163,100	174,500	5.0
[illegible]	0.029	0.263	0.166	14.6	153,800	156,600	170,300	5.5
45-1	0.029	0.364	0.571	13.0	147,300	149,300	154,100	7.5
45-2	0.029	0.369	0.714	13.4	145,800	149,300	153,500	8.0
T1	0.028	0.271	0.149	15.5	157,900	162,100	175,000	2.5
T2	0.027	0.263	0.133	15.3	154,100	157,000	166,700	5.0

Ti-16V-2.5Al-B24814



(110) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

HEAT TREATMENT

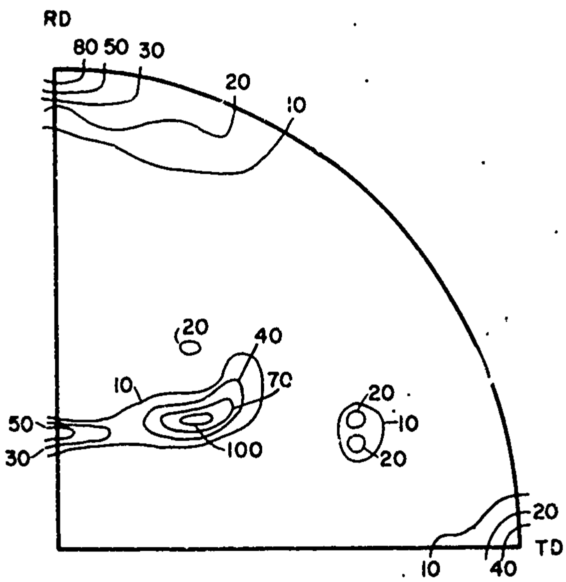
Solution treated at 1450F, 1/2 hr w.q.

MECHANICAL PROPERTIES

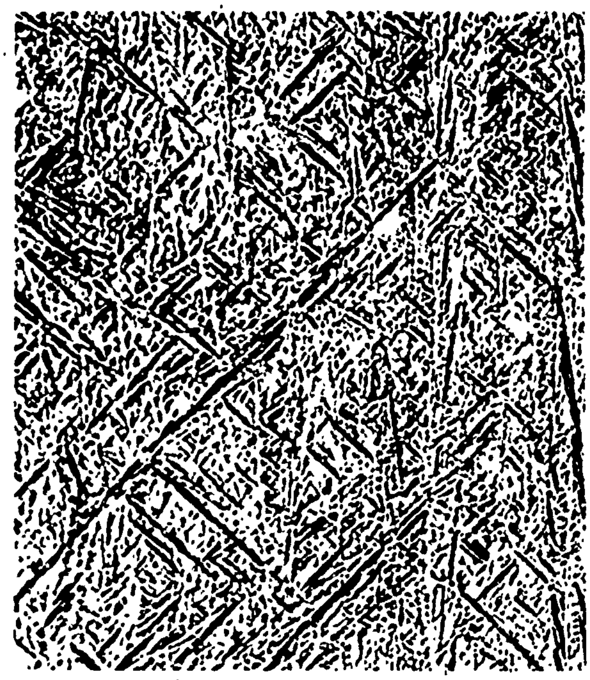
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	$Ex10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
-10	0.024	0.353	0.319	11.6	52,100	58,300	100,000	9.0
0	0.025	*	*	10.6	63,500	71,000	125,000	-
10	0.025	*	*	-	56,800	64,000	109,600	7.0
20	0.026	0.363	0.345	10.6	53,800	61,600	114,500	12.0
30	0.025	0.353	0.304	10.7	53,900	61,500	108,700	5.5
40	0.026	0.364	0.359	11.9	59,900	67,600	117,200	10.0
50	0.025	0.364	0.352	11.1	55,600	63,500	113,500	8.0
60	0.026	0.375	0.346	10.6	56,900	63,700	113,000	8.0
70	0.025	0.389	0.439	11.1	53,200	62,[illegible]00	109,200	4.5
80	0.027	.346	0.328	9.6	58,900	65,600	111,900	9.5
90	0.027	0.400	0.407	11.6	58,900	66,600	112,500	
100	0.026	0.366	0.404	10.6	50,800	57,600	107,600	6.0

*Premature gage failure

Ti-16V-2.5Al-M22093



(110) POLE FIGURE



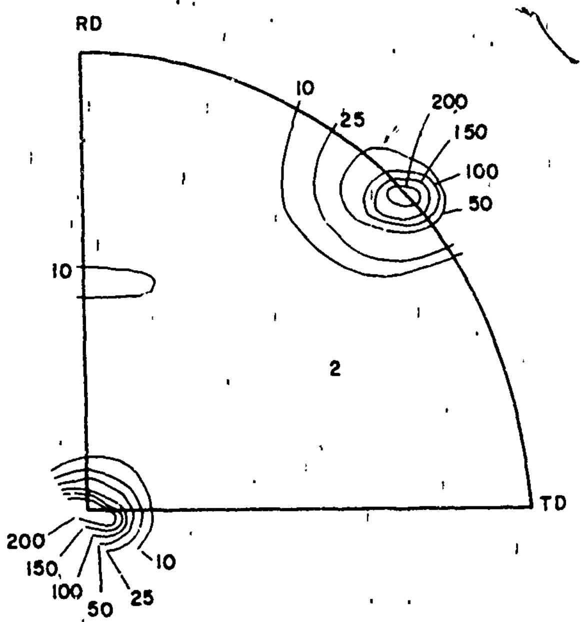
ETCHED MICROSTRUCTURE (500X)

MECHANICAL PROPERTIES

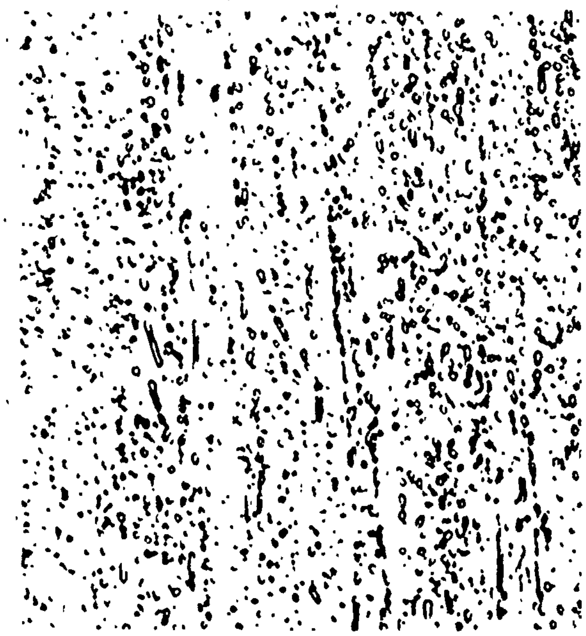
Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.025	0.114	*	11.1	60,000	65,600	110,000	18.5
10	0.025	0.220	0.071	11.0	56,000	61,600	107,600	19.0
20	0.026	0.287	0.230	10.6	53,500	59,600	113,100	13.5
30	0.026	0.350	0.333	9.6	48,500	55,000	125,400	14.5
40	0.026	0.390	0.435	9.4	50,000	55,500	128,800	13.0
50	0.026	0.404	0.459	9.7	44,200	51,900	124,200	14.0
60	0.026	0.369	0.317	9.7	46,200	52,300	128,800	14.5
70	0.026	0.291	0.151	10.2	55,000	60,000	114,600	11.0
80	0.025	0.214	*	11.9	61,600	66,400	102,000	19.0
90	0.026	0.191	*	11.8	61,500	66,900	100,800	19.0

*Premature gage failure

Ti-16V-2.5Al-B22117



(100) POLE FIGURE

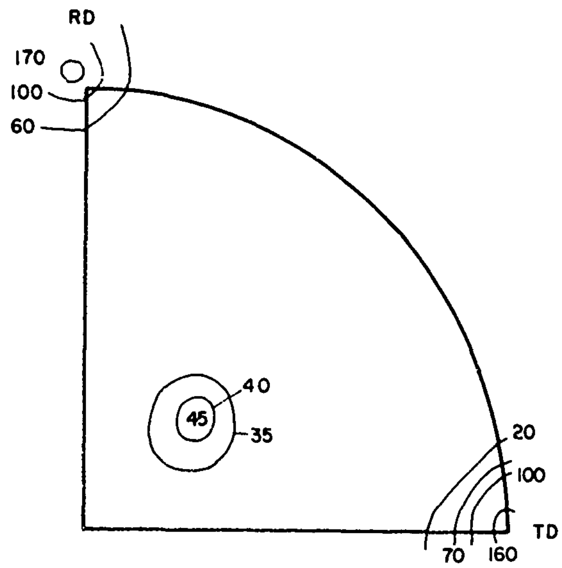


ETCHED MICROSTRUCTURE (1000X)

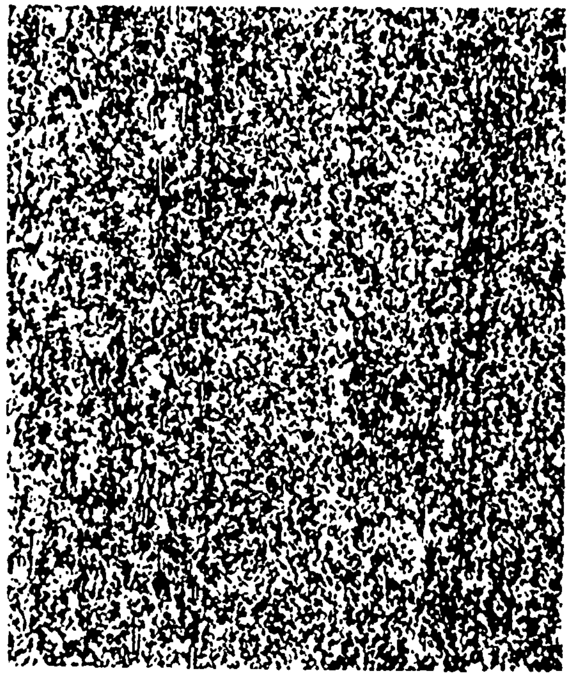
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thickness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.044	0.21	0.11	12.4	71,400	75,900	105,200	
10	0.045	0.25	0.14	13.3	78,300	81,400	110,600	
20	0.046	0.25	0.08	[illegible]	82,300	86,100	112,600	
30	0.046	0.37	0.36	11.0	90,900	97,000	116,900	
40	0.046	0.40	0.45	10.3	87,600	96,400	118,600	
50	0.047	0.41	0.46	10.6	87,300	96,200	117,400	
60	0.047	0.38	0.41	10.9	89,400	97,400	118,100	
70	0.047	0.32	0.24	11.6	90,400	94,900	115,700	
80	0.047	0.23	0.10	12.4	90,000	93,600	112,300	
90	0.047	0.21	0.11	13.6	89,400	92,800	110,600	
0	0.045	0.196	0.044	11.7	62,000	66,700	111,100	19.5
10	0.046	0.202	0.038	11.5	59,783	65,200	110,900	15.5
20	0.046	0.275	0.178	10.1	55,652	62,000	119,600	14.0
30	0.046	0.335	0.310	9.1	51,087	57,800	127,200	16.0
40	0.046	0.358	0.389	8.8	47,826	54,800	130,400	15.5
45	0.046	0.364	0.350	9.9	82,969	93,900	111,400	16.0
[illegible]	0.046	0.403	0.492	8.8	50,400	56,500	129,300	14.0
[illegible]	0.046	0.364	0.353	9.4	50,000	56,500	123,900	14.0
[illegible]	0.045	0.289	0.228	11.1	58,200	64,900	117,800	10.0
[illegible]	0.046	0.222	0.154	12.1	64,348	70,000	108,300	13.0
90	0.046	0.175	0.056	13.1	68,696	64,300	111,700	20.5

Ti-16V-2.5Al-B22117



(0002) POLE FIGURE

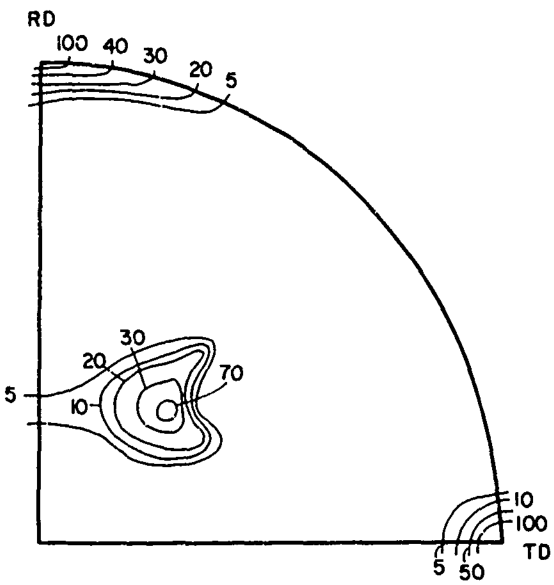


ETCHED MICROSTRUCTURE (1000X)

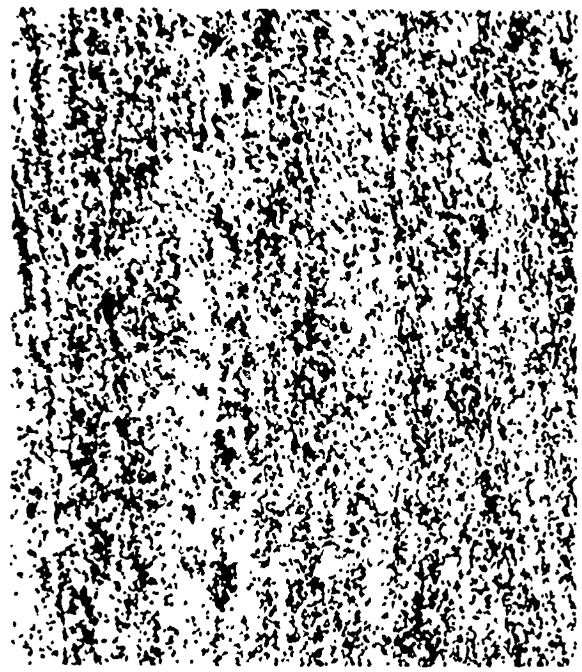
HEAT TREATMENT

Aged at 975F, 4 hr ac

Ti-16V-2.5Al-M24990



(0002) POLE FIGURE

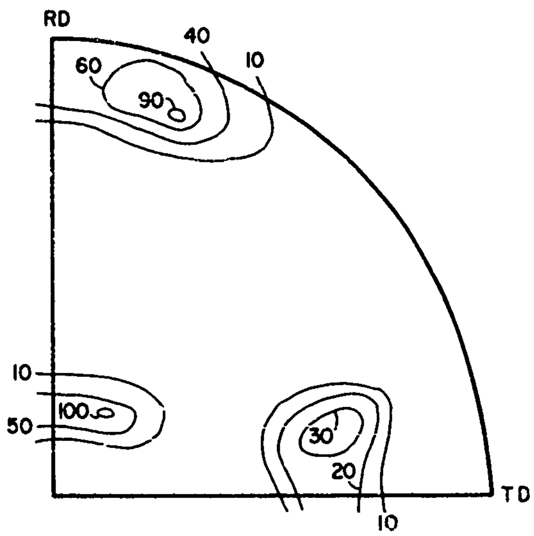


ETCHED MICROSTRUCTURE (500X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.022	0.250	0.136	15.2	152,700	156,400	170,000	4.5
10	0.023	0.262	0.179	14.7	153,900	156,500	169,100	4.5
20	0.023	0.287	0.243	14.7	153,500	156,500	169,100	7.5
30	0.024	0.318	0.300	13.4	142,500	146,300	155,400	5.5
40	0.024	0.340	0.581	13.1	143,300	146,300	152,100	6.5
50	0.024	0.339	0.361	12.9	141,700	144,600	149,600	7.0
60	0.023	0.333	0.353	14.0	147,800	151,700	159,100	5.0
70	0.023	0.286	0.232	14.5	152,200	156,500	168,700	7.5
80	0.023	0.267	0.192	14.5	148,300	151,300	162,600	3.5
90	0.023	0.250	0.154	14.8	150,900	153,900	164,300	3.5

Ti-16V-2.5Al-B24990



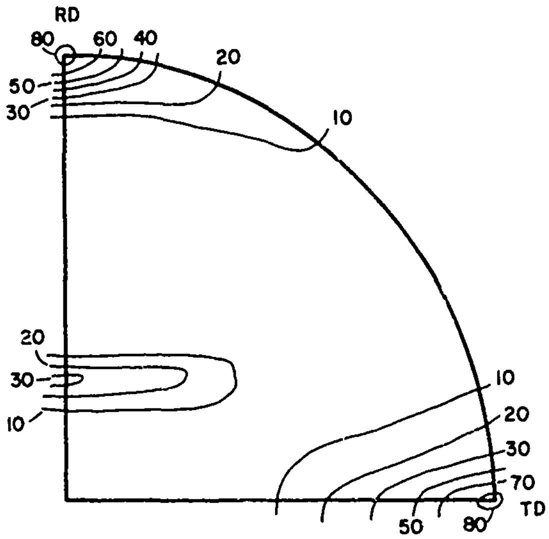
(110) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

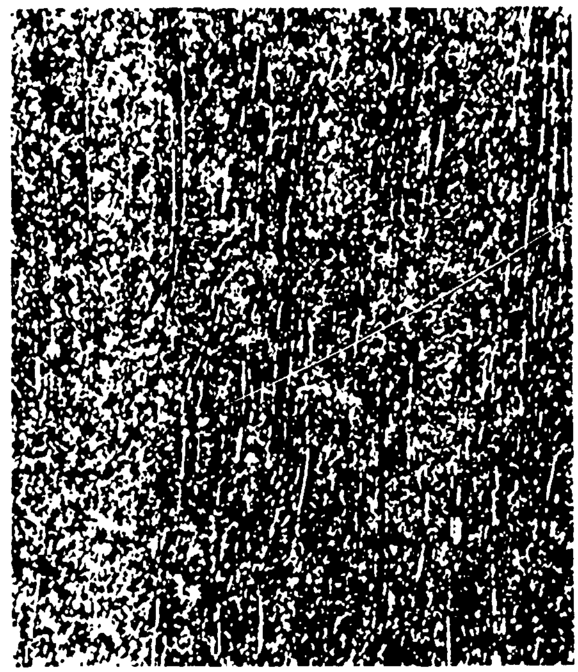
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thickness (inch)	μ_E	μ_p	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.039	0.336	0.42	11.7	65,800	71,800	114,400	-
10	0.040	0.313	0.30	11.0	66,000	73,300	115,000	-
20	0.040	0.352	0.40	10.9	65,000	71,500	117,000	-
30	0.040	0.384	0.45	10.0	64,300	71,000	119,500	-
40	0.041	0.408	0.52	10.5	62,700	69,500	119,000	-
50	0.040	0.400	0.51	11.9	62,300	70,300	122,000	-
60	0.040	0.403	0.56	11.3	67,800	76,500	121,300	-
70	0.040	0.377	0.46	11.7	73,800	82,000	118,000	-
80	0.041	0.361	0.43	12.6	92,200	95,900	113,200	-
90	0.041	0.338	0.38	12.6	78,400	86,800	111,800	-
0	0.040	0.327	0.255	11.4	63,500	69,300	110,500	20.5
10	0.041	0.333	0.306	11.6	63,400	69,500	112,200	17.5
20	0.041	0.348	0.363	10.6	62,200	68,800	115,900	17.0
30	0.041	0.373	0.421	10.3	62,200	68,300	118,300	17.5
40	0.041	0.394	0.476	10.1	62,200	68,300	118,800	15.5
50	0.041	0.413	0.513	10.6	62,200	71,500	116,600	17.0
60	0.041	0.405	0.525	11.0	64,600	72,000	116,100	16.5
70	0.041	0.393	0.534	11.4	69,800	77,300	114,600	15.0
80	0.041	0.345	0.423	12.2	75,100	82,900	112,700	14.0
90	0.040	0.370	0.466	11.8	75,000	82,500	108,800	14.0

Ti-16V-2.5Al-M23346



(0002) POLE FIGURE

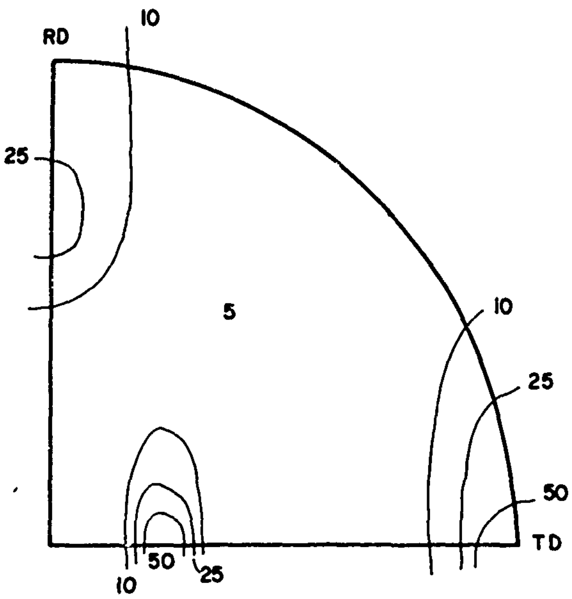


ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.070	0.281	0.206	14.8	127,500	129,600	143,900	11.5
10	0.071	0.289	0.252	14.8	132,000	134,600	148,200	12.5
20	0.071	0.296	0.276	14.2	126,400	129,200	139,000	12.0
30	0.070	0.307	0.360	13.4	128,900	131,100	139,600	12.5
40	0.070	0.325	0.442	14.3	125,700	126,900	132,600	12.0
50	0.070	0.335	0.454	14.3	128,900	131,100	135,800	10.0
60	0.070	0.329	0.423	14.9	133,000	134,700	141,000	14.0
70	0.070	0.304	0.282	15.3	137,200	140,200	149,100	10.5
80	0.071	0.290	0.287	15.6	138,900	142,200	152,100	11.0
90	0.070	0.284	0.161	15.9	141,300	144,900	155,900	9.0

Ti-16V-2.5Al-T22154



(0002) POLE FIGURE

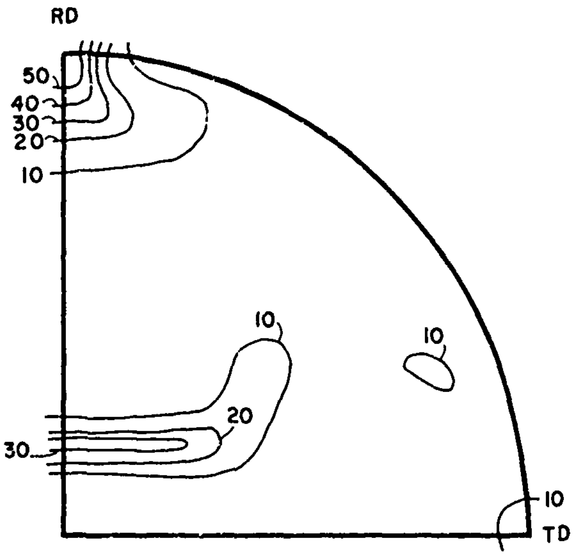
ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	$E\times10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.061	0.320	0.336	14.9	158,800	163,100	179,100	6.0
10	0.065	0.307	*	14.3	159,500	162,000	176,700	9.0
20	0.066	0.330	*	14.4	155,900	159,800	175,500	8.0
30	0.066	0.333	0.453	14.4	156,000	159,800	174,200	6.5
40	0.066	0.338	0.424	14.3	158,900	162,800	175,200	8.5
50	0.067	0.342	0.473	14.3	159,500	164,000	175,000	6.5
60	0.066	0.337	0.515	14.6	163,100	167,800	178,200	6.5
70	0.066	0.325	*	14.8	165,900	169,500	180,700	5.5
80	0.066	0.321	0.384	14.7	167,100	171,900	182,800	6.5
90	0.066	0.333	0.427	14.9	166,600	171,600	181,600	5.5

*Premature gage failure

Ti-16V-2.5Al-T24762



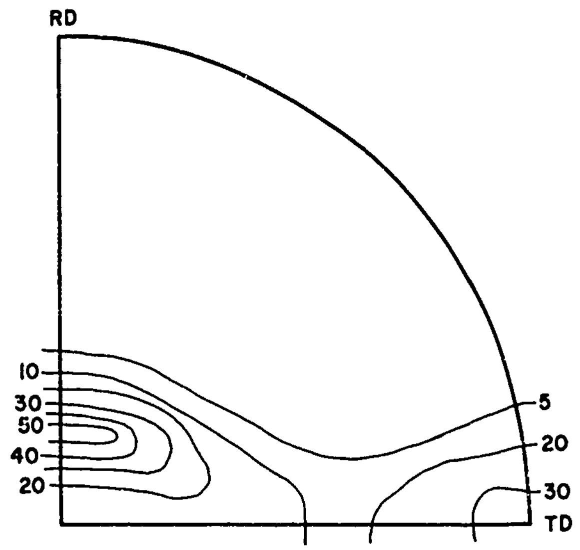
(0002) POLE FIGURE

ETCHED MICROSTRUCTURE (1000X)

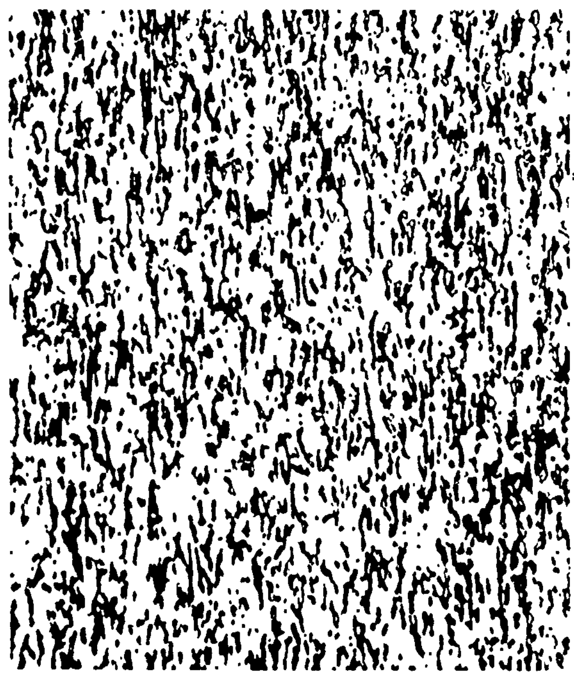
MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_P	$E \times 10^6$ Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.130	0.303	0.296	15.3	158,500	161,700	174,200	8.0
10	0.129	0.298	0.310	14.9	158,100	162,000	177,500	7.0
20	0.130	0.335	0.332	14.7	159,200	163,100	175,400	8.0
30	0.130	0.324	0.390	14.7	156,200	160,800	173,800	9.5
40	0.130	0.327	0.446	14.4	160,000	165,400	173,800	8.5
50	0.131	0.335	0.477	14.2	158,800	164,100	174,800	10.5
60	0.130	0.346	0.445	14.4	163,800	169,200	178,500	7.5
70	0.129	0.323	0.392	15.9	170,500	179,100	189,100	8.0
80	0.129	0.340	0.277	15.5	171,300	177,500	190,300	7.0
90	0.130	0.314	0.309	15.2	172,300	177,700	188,500	5.5

APPENDIX IX
Ti-7Al-3Mo-1295



(0002) POLE FIGURE



ETCHED MICROSTRUCTURE (1000X)

MECHANICAL PROPERTIES

Specimen Orientation α (degrees)	Thick-ness (inch)	μ_E	μ_p	Ex10^6 Strain Gage (psi)	Y.S. at 0.1% (psi)	Y.S. at 0.2% (psi)	Tensile Strength (psi)	Elon. (%)
0	0.062	0.354	0.656	16.2	154,200	155,200	167,100	13.0
20	0.062	0.365	0.663	16.4	162,400	156,600	162,400	11.5
40	0.062	0.376	0.778	16.6	149,500	150,300	151,900	15.0
50	0.062	0.385	0.795	17.0	149,200	149,500	150,200	14.0
60	0.062	0.392	0.795	16.7	153,500	154,800	154,800	12.5
70	0.062	0.384	0.719	17.1	157,400	158,700	159,700	11.0
80	0.060	0.375	*	18.2	163,200	161,200	163,900	7.0
90	0.060	0.375	*	18.4	159,200	159,200	161,500	6.0

*Prematur gage failure